WELCOME TO TECHNICAL ORDER 00-105E-9.

THIS IS SEGMENT 1 COVERING TITLE PAGE, A & B PAGES, FOREWORD, LIST OF ILLUSTRATIONS, FFA/ICAO DESIGNATORS, AND CHAPTERS 1, 2, AND 3.

IF YOU WOULD LIKE TO GO DIRECTLY TO THE TECHNICAL ORDER, CLICK ON THE CONTINUE BUTTON.

TO SEE THE SEGMENT INFORMATION CHANGE NOTICE, CLICK ON THE NOTICE BUTTON.

CONTINUE

NOTICE

CONTACT

IF YOU NEED TO CONTACT THE TECHNICAL CONTENT MANAGER FOR THIS TECHNICAL ORDER, CLICK ON THE CONTACT BUTTON.

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For technical order improvements, correcting procedures, and other inquiries, please use the above media most convenient.

SEGMENT 1 INFORMATION CHANGE NOTICE

This page is provided to notifiy the user of any informational changes made to Technical Order 00-105E-9 in this Segment and the current Revision. Informational changes will be referenced in the Adobe Reader's Bookmark tool as a designator symbol illustrated as a <[C]> for quick reference to the right of the affected aircraft. The user shall insure the most current information contained in this TO is used for his operation. Retaining out of date rescue information can negatively affect the user's operability and outcome of emergencies. If the user prints out pages his unit requires, the user shall print the affected page(s), remove and destroy the existing page(s), and insert the newly printed page(s) in the binder provided for that purpose. A Master of this TO shall be retained in the unit's library for reference, future printing requirements and inspections.

CHAPTER	AIRCRAFT	PAGE	EXPLANATION OF CHANGE
Title Page	N/A	Title	Supercedes Revision of 15 January 2001. New title for manual.
A Page	N/A	A	TO chronology added and explanation of revision.
B Page	N/A	B	Added.
LOI	All	All	Updated.
Foreword	N/A	All	Updated.
FAA/ICAO Designators		All	Added FAA Appendices A and B.
1	N/A	All	Chapter updated. Special interests: Printing the TO and use of the AFTO Form 88.
2	N/A	All	Chapter updated. Added Confined Space info for USAF aircraft.
3	N/A	All	Chapter updated, revised and expanded to include chemicals, HAZMAT, composites, radio active materials, & DU. Tables, checklists, and flowcharts added.

TO 00-105E-9

TECHNICAL MANUAL

AEROSPACE

EMERGENCY RESCUE AND MISHAP RESPONSE INFORMATION

(EMERGENCY SERVICES)

THIS PUBLICATION SUPERCEDES TO 00-105E-9, REVISION 8, DATED 15 JANUARY 2001 AND SAFETY SUPPLEMENTS 1, 2, 3, 4, 5, 6 and 7.

THE FORMER TECHNICAL MANUAL TITLE FOR THIS NUMERICAL DESIGNATION WAS "AIRCRAFT EMERGENCY RESCUE INFORMATION (FIRE PROTECTION)".

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PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

REVISION 8

30 September 2002

LATEST REVISION. DESTROY SUPERCEDED REVISIONS.

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NOTE:
According to official WR-ALC/TI records, this is the numerical and chronological order for all revisions and changes to this technical order. When the TO was converted to electronic media, the revision was temporarily considered an original, but TO management dictates that the historical order be restored to keep the TO records accurate. The A and B pages will reflect this order as applicable.--TO Content Manager and Editor.

THIS PUBLICATION CONSISTS OF THE FOLLOWING:

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FOREWORD

This Technical Order (TO) has been designed to provide information and establish procedures that may be encountered during various types of emergencies on US Air Force, US Army, selected commercial for the Civil Reserve Airfleet, US Navy/Marines, and NATO aircraft. Each emergency presents a different problem, but with a thorough knowledge of the TO, you as a Fire Protection or Emergency Services Technician can make knowledgeable decisions in performing a critical aircraft rescue or incident mishap response. Aircraft accident personnel, from post fire to clean-up should also be familiar with this information to aid in a successful conclusion to a aircraft incident.

Firefighting and emergency response is a highly technical profession in and around grounded or crashed aircraft and the **rescue of aircraft occupants will take precedence over all other operations until it is established that there is no further life hazard involved.** The secondary responsibility is to **extinguish and limit the damage to the aircraft by fire or explosion.** During the rescue of entrapped personnel, the sequence of events listed in this TO should be followed. **<u>Due to the variations injected in every situation, the senior firefighting officer-in-charge has the prerogative to change or alter the sequencing of events as he/she deems necessary.</u>** In addition, the senior firefighting officer-in-charge may use all equipment and resources available to accomplish the rescue regardless of prescribed instructions contained within this TO. Preplanning for various emergencies is another extremely important function of the Fire Protection or Emergency Response Technician. Each technician must know his/her duties as they are outlined in the pre-planning for aircraft emergencies. This knowledge cannot be acquired solely from the study of the diagrams published in this TO and should not be construed to replace or substitute frequent "hands-on" training with crew members and aircraft.

Constant attention must be given to the aircraft construction, position and location of crew members and passengers, aircraft skin penetration points, normal and emergency entry points (internal and external), ejection seat safety and canopy jettison removal with associated impact areas for ejected seats and canopies, armament, fuel amount, oxygen systems, batteries, overheated brakes and exploded wheel shrapnel areas, engine intake and exhaust danger areas, radar emitting areas, composite material areas, various hazardous chemicals, gases, fluids, possible radioactive materials and all other points of interest that would lead to early rescue of aircraft personnel safely. Therefore, it is essential that all material contained herein be studied and assimilated by all Fire Protection and aircraft accident personnel.

Any technical content questions about TO 00-105E-9, contact:

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LIST OF ILLUSTRATIONS

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MILITARY AIRCRAFT PREFIX IDENTIFICATION/FUNCTION FOR THIS MANUAL

PREFIX ID	MILITARY FUNCTION	PREFIX ID	MILITARY FUNCTION
A	ATTACK	N	TEST BED
B	BOMBER	O	OBSERVATION
C	CARGO/TRANSPORT	Q	SPECIAL TEST
E	ELECTRONIC	R	RECONNAISSANCE
F	FIGHTER	S	STRATEGIC
H	HELICOPTER	T	TRAINER
K	TANKER	U	UTILITY
M	SPECIAL OPERATIONS	V	VIP CARRIER

NOTE: COMBINATION OF PREFIXES DENOTES MULTI-ROLE MISSION. DOES NOT APPLY TO NATO AIRCRAFT.

NATO NATION DESIGNATIONS

BE: BELGIUM	NL: NETHERLANDS
CA: CANADA	NO: NORWAY
CR: CZECH REPUBLIC	PL: POLAND
DE: DENMARK	PO: PORTUGAL
FR: FRANCE	RO: ROMANIA
GE: GERMANY	SP: SPAIN
GR: GREECE	TU: TURKEY
IC: ICELAND	UK: UNITED KINGDOM
IT: ITALY	US: UNITED STATES
LU: LUXEMBOURG	

PARTNERS FOR PEACE (PFP) NATION DESIGNATIONS

AL: ALBANIA	LA: LATVIA
AZ: AZERBAIJAN	LI: LITHUANIA
BU: BULGARIA	MO: MOLDOVA
ES: ESTONIA	RU: RUSSIA
FI: FINLAND	SL: SLOVAKIA
GO: GEORGIA	SO: SLOVENIA
HU: HUNGARY	SW: SWEDEN
KA: KAZAKHSTAN	TR: TURKMENISTAN
KY: KYRGYZSTAN	UR: UKRAINE

OTHER DESIGNATIONS

SW: SWEDEN	EU: EUROPEAN UNION

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FAA/ICAO DESIGNATORS

Different aircraft designations between the military and Federal Aviation Adminstration (FAA) / International Civil Aviation Organization (ICAO) have been known for sometime. However, air traffic control (ATC) have adopted the official source for FAA/ICAO aircraft designations IAW FAA Order 7110.65, *Air Traffic Control* and ICAO standards. ATC is required to use the official designators in all written and verbal communications. This action has been adopted by the military and has led to confusion in correctly identifying aircraft by military emergency responders. To solve this problem and eliminate emergency response delays, the FAA AT publication Appendices A and B have been added to this publication to help in the identification process.

Appendix A.

Aircraft Information

TYPE ENGINE ABBREVIATIONS

P	piston
T	jet/turboprop
J	jet

CLIMB AND DESCENT RATES

Climb and descent rates based on average en route climb/descent profiles at median weight between maximum gross takeoff and landing weights.

SRS

SRS means "same runway separation;" categorization criteria is specified in para 3-9-6, Same Runway Separation.

MANUFACTURERS

Listed under the primary manufacturer are other aircraft manufacturers who also make versions of some of the aircraft in that group.

AIRCRAFT WEIGHT CLASSES

a. Heavy. Aircraft capable of takeoff weights of more than 255,000 pounds whether or not they are operating at this weight during a particular phase of flight.

b. Large. Aircraft of more than 41,000 pounds, maximum certificated takeoff weight, up to 255,000 pounds.

c. Small. Aircraft of 41,000 pounds or less maximum certificated takeoff weight.

STAGE 3 AIRCRAFT DESIGNATORS

Stage 3 aircraft designators such as B72Q, B73Q, DC8Q, DC9Q are only for use within the U.S. These designators will not be recognized in Canadian airspace or any other airspace outside the U.S.

NOTE -
** Denotes single-piloted military turbojet aircraft or aircraft to receive the same procedural handling as a single-piloted military turbojet aircraft.*

+ Denotes aircraft weighing between 12,500 lbs. and 41,000 lbs. For Class B Airspace rules, these aircraft are "large, turbine-engined powered aircraft."

Fixed-Wing Aircraft

AERONCA (USA- see Bellanca)

AERO SPACELINES (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Super Guppy, Super Turbine Guppy	SGUP	4T/L	1,500	1,500	III

AEROSPATIALE (France)

(Also MORANE-SAULNIER, PZL-OKECIE, SOCATA, SUD, SUD-EST, TBM)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Rallye, Rallye Club, Super Rallye, Rallye Commodore, Minerva (MS-880 to 894)	RALL	1P/S	750	750	I
Caravelle SE 210	S210	2J/L	2,300	2,000	III
Corvette SN601	S601	2J/S+	2,500	2,000	III
Tampico TB-9	TAMP	1P/S	600	700	1
TBM TB-700	TBM7	1T/S	1,700	1,500	1
Tabago TB10C/200	TOBA	1P/S	700	700	1
Trinidad TB-20/21	TRIN	1P/S	850	700	1

AEROSPATIALE/AERITALIA (France/Italy)

(Also ATR, ALENIA)

Model	Type	Description	Performance

		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
ATR-42-200/300/320	AT43	2T/L	2,000	2,000	III
ATR-42-400	AT44	2T/L	2,000	2,000	III
ATR-42-500	AT45	2T/L	2,000	2,000	III
ATR-72	AT72	2T/L	2,000	2,000	III

AEROSPATIALE/BRITISH AEROSPACE (France/UK)

(Also BAC, SUD, SUD-BAC)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Concorde	CONC	4J/H	5,000	5,000	III

AIRBUS INDUSTRIES (International)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
A300B2	A30B	2J/H	3,500	3,500	III
A300B4 - 600	A306	2J/H	3,500	3,500	III
A310	A310	2J/H	3,500	3,500	III
A319	A319	2J/L	3,500	3,500	III
A320	A320	2J/L	3,500	3,500	III
A321	A321	2J/L	3,500	3,500	III
A330	A330	2J/H	3,500	3,500	III
A340	A340	4J/H	3,500	3,500	III

AIR TRACTOR , INC. (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Air Tractor 401/301	AT3P	1P/S	1,000	-	I

ALON, INC. (USA)

(Also AIR PRODUCTS, ERCO, FORNAIRE, FORNEY, MOONEY)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Aircoupe A2/F-1	ERCO	1P/S	630	630	I

ASTRA JET (USA - see Israel Aircraft Industries)

AVIONS MUDRY ET CIE (France) (Now called MUDRY)

(Also CAARP)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Cap 10	CP10	1P/S	1,500	2,000	I
Cap 20	CP20	1P/S	1,500	2,000	I

BEAGLE AIRCRAFT (UK)

(Also BEAGLE-AUSTER)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
B.206 Basset Series	BASS	2P/S	1,200	1,300	II
B.121 Pup Series	PUP	1P/S	575	750	I

BEECH AIRCRAFT COMPANY (USA)

(Also CCF, COLEMILL, DINFIA, EXCALIBUR, FUJI, HAMILTON, JETCRAFTERS, RAYTHEON, SWEARINGEN, VOLPAR)

Model	Type Designator	Description	Performance Information

		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Beech 1900/C-12J	B190	2T/S+	2,400	2,400	III
Super King Air 350	B350	2T/S+	3,000	3,000	III
King Air 100 A/B (U-21F Ute)	BE10	2T/S	2,250	2,250	II
Stagger Wing 17 (UC-43 Traveler)	BE17	1P/S	1,375	1,375	I
Twin Beech 18/Super H18	BE18	2P/S	1,400	1,000	II
Sport 19, Musketeer Sport	BE19	1P/S	680	680	I
Super King Air 200, 1300	BE20	2T/S+	2,450	2,500	II
Sundowner 23, Musketeer 23	BE23	1P/S	740	800	I
Sierra 24, Musketeer Super	BE24	1P/S	1,000	1,000	I
Super King Air 300/300LW	BE30	2T/S+	3,000	3,000	III
Bonanza 33, Debonair (E-24)	BE33	1P/S	1,000	1,000	I
Bonanza 35	BE35	1P/S	1,200	1,200	I
Bonanza 36	BE36	1P/S	1,100	1,100	I
Beechjet 400/T-1 Jayhawk	BE40	2J/S+	3,300	2,200	III
Twin Bonanza 50	BE50	2P/S	1,600	1,600	II
Baron 55/Chochise	BE55	2P/S	1,700	1,700	II
Baron 58, Foxstar	BE58	2P/S	1,730	1,730	II
Duke 60	BE60	2P/S	1,600	1,600	II
Queen Air 65 (U-8F Seminole)	BE65	2P/S	1,300	1,300	II
Duchess 76	BE76	2P/S	1,500	1,500	II
Skipper 77	BE77	1P/S	750	750	I
Queen Air 80	BE80	2P/S	1,275	1,275	II
Travelair 95	BE95	2P/S	1,250	1,250	II
Airliner 99	BE99	2T/S	1,750	1,750	II
King Air 90, A90 to E90 (T-44, V-C6), Taurus 90	BE9L	2T/S	2,000	2,000	II
Beech F90 King Air	BE9T	2T/S	2,600	2,600	II
Starship 2000	STAR	2T/S+	2,650	2,650	III
Mentor T34A/B, E-17	T34P	1P/S	1,150	1,150	I
Turbo Mentor T-34C	T34T	1T/S	1,100	1,000	I
Ute	U21	2T/S	2,000	2,000	II

BELLANCA AIRCRAFT (USA)

(Also AERONCA, CHAMPION, DOWNER, HINDUSTAN, NORTHERN)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Aeronca Chief/Super Chief, Pushpak	AR11	1P/S	500	500	I
Aeronca Sedan	AR15	1P/S	500	500	I
Cruisair, Cruismaster 14-19	B14A	1P/S	1,030	1,030	I
Super Viking,Turbo Viking	BL17	1P/S	1,100	1,100	I
Decathlon, Super Decathlon, Scout 8	BL8	1P/S	1,000	1,000	I
Champion Lancer 402	CH40	2P/S	650	1,000	II
7 Champion Citabria, Traveler, Tri-Con, Tri-Traveler, Champ 7AC/7ACA/7BCM/ 7CC/7CCM/7DC/ 7EC/7ECA/7FC/7JC	CH7A	1P/S	750	750	I
7 Champion Challenger, Citabria, DX'er, Olympia, SkyTrac 7GC/7GCA/ 7GCAA/7GCB/ 7GCBA/7GCBC/ 7HC/7KC/7KCAB	CH7B	1P/S	1,100	1,100	I

BOEING COMPANY (USA)

(Also GRUMMAN, NORTHROP-GRUMMAN, IAI)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Stratofortress	B52	8J/H	3,000	3,000	III
707-100, VC-137707-100, VC-137	B701	4J/H	3,500	3,500	III

707-300, E-8 J-Stars, EC-137	B703	4J/H	3,500	3,500	III
717-200	B712	2J/L	-	-	III
720	B720	4J/L	3,000	3,000	III
727-100 (C-22)	B721	3J/L	4,500	4,500	III
727-200	B722	3J/L	4,500	4,500	III
727 Stage 3 (-100 or -200)	B72Q	3J/L	4,500	4,500	III
737-100	B731	2J/L	3,000	3,000	III
737-200 (Surveiller, CT-43, VC-96)	B732	2J/L	3,000	3,000	III
B737 Stage 3	B73Q	2J/L	3,000	3,000	III
737-300	B733	2J/L	5,500	3,500	III
737-400	B734	2J/L	6,500	3,500	III
737-500	B735	2J/L	5,500	3,500	III
737-600	B736	2J/L	4,000	4,000	III
737-700	B737	2J/L	4,000	4,000	III
737-800	B738	2J/L	4,000	4,000	III
747-100	B741	4J/H	3,000	3,000	III
747-200	B742	4J/H	3,000	3,000	III
747-300	B743	4J/H	3,000	3,000	III
747-400	B744	4J/H	3,000	3,000	III
747SR	B74R	4J/H	3,000	3,000	III
747SP/SUD	B74S	4J/H	3,000	3,000	III
757-200	B752	2J/L	3,500	2,500	III
757-300	B753	2J/L	3,500	2,500	III
767-200	B762	2J/H	3,500	3,500	III
767-300	B763	2J/H	3,500	3,500	III
767 AWACS (E-767)	E767	2J/H	2,500	2,500	III
777-200	B772	2J/H	2,500	2,500	III
777-300	B773	2J/H	2,500	2,500	III
C-135 Stratolifter (EC-135, NKC-135, OC-135, TC-135, WC-135)	C135	4J/H	2,000	2,000	III
Stratotanker KC-135A (J57)	K35A	4J/H	2,500	3,000	III
Stratotanker KC-135D/E (TF33)	K35E	4J/H	5,000	3,000	III
Stratotanker KC-135R/T (CFM56)	K35R	4J/H	5,000	3,000	III

RC-135	R135	4J/H	3,000	3,000	III
Stratofreighter	C97	4P/L	2,500	3,000	III
E-3A (TF33)/B/C Sentry	E3TF	4J/H	3,500	4,000	III
E6 Mercury	E6	4J/	3,500	3,500	III
KE-3	KE3	4J/	3,500	3,500	III
Stearman	ST75	1P/S	840	840	I

BRITISH AEROSPACE (BAe) (UK)

(Also AIL, AVRO, BAC, BUCURESTI, DE HAVILLAND, HANDLEY-PAGE, HAWKER-SIDDELEY, JETSTREAM, KANPUR, MCDONNELL-DOUGLAS, RAYTHEON, SCOTTISH-AVIATION, VOLPAR)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
BAe HS 748 (Andover, C-91)	A748	2T/L	2,500	2,000	III
Jetstream 61, Advance Turboprop (ATP)	ATP	2T/L	3,000	3,000	III
BAC One-Eleven	BA11	2J/L	2,400	2,400	III
BAe 146, RJ, Quiet Trader, Avroliner	BA46	4J/L	3,500	3,500	III
BAe HS 125 Series 1/2/3/400/600	H25A	2J/S+	2,500	2,000	III
BAe HS 125 Series 700/800	H25B	2J/S+	3,000	4,000	III
BAe HS 125 Series 1000	H25C	2J/S+	3,000	4,000	III
BAe Harrier	HAR*	1J/L	5,000	8,000	III
Jetstream 1	JS1	2T/S+	2,200	2,200	III
Jetstream 200	JS20	2T/S+	2,200	2,200	III
Jetstream 3	JS3	2T/S+	2,200	2,300	III
BAe-3100 Jetstream 31	JS31	2T/S+	2,200	2,200	III
BAe-3200 Jetstream Super 31	JS32	2T/S+	2,600	2,600	III
BAe-4100 Jetstream 41	JS41	2T/L	2,200	-	III

BRITTEN NORMAN LTD. (a subsidiary of Pilatus Aircraft LTD.) (UK)

(Also AVIONS FAIREY, BAC, BUCURESTI, DE HAVILLAND, HAWKER-SIDDELEY, IRMA, PADC, ROMAERO, VICKERS)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
BN-2A/B Islander, Defender	BN2P	2P/S	1,250	1,250	II
BN-2T Turbine Islander, Turbine Defender	BN2T	2T/S	1,500	1,500	II
Trident	TRID	3J/L	3,000	3,000	III
BN-2A Mark III Trislander	TRIS	3P/S	1,200	1,000	III
VC-10	VC10	4J/H	1,900	2,000	III
Viscount	VISC	4T/L	1,200	1,500	III

BUSHMASTER AIRCRAFT CORP. (USA)
(Now AIRCRAFT HYDRO-FORMING)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Bushmaster 2000	BU20	3P/S+	2,000	2,000	III

CAMAIR AIRCRAFT CORP. (USA)

(Also RILEY, TEMCO)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Twin Navion 480, 55, D-16	TNAV	2P/S	1,800	2,000	II

CANADAIR BOMBARDIER LTD. (Canada)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Regional Jet	CARJ	2J/L	3,000	-	III
CL600/610 Challenger	CL60	2J/L	2,250	3,000	III

CESSNA AIRCRAFT COMPANY (USA)

(Also AVIONES-COLOMBIA, COLEMILL, DINFIA, ECTOR, FMA, FUJI, REIMS, RILEY, SUMMIT, WREN)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Dragonfly 318E	A37*	2J/S	3,370	3,000	III
Cessna 120	C120	1P/S	640	640	I
Cessna 140	C140	1P/S	640	640	I
Cessna 150	C150	1P/S	670	1,000	I
Cessna 152	C152	1P/S	750	1,000	I
Cessna 170	C170	1P/S	690	1,000	I
Skyhawk 172/Cutlass/ Mescalero	C172	1P/S	650	1,000	I
Cutlass RG, 172RG	C72R	1P/S	650	1,000	I
Skylark 175	C175	1P/S	850	1,000	I
Cardinal 177	C177	1P/S	850	1,000	I
Cardinal RG, 177RG	C77R	1P/S	850	1,000	I
Skywagon 180 (U-17C)	C180	1P/S	1,130	1,130	I
Skylane 182	C182	1P/S	890	1,000	I
Skylane RG, Turbo Skylane RG, R182, TR182	C82R	1P/S	890	1,000	I
Skywagon 185 (U-17A/B)	C185	1P/S	1,000	1,000	I
AGWagon/AGTruck/ AGHusky 188	C188	1P/S	1,000	1,000	I
Cessna 190	C190	1P/S	1,090	1,090	I
Cessna 195	C195	1P/S	1,200	1,200	I
Super Skywagon/Super Skylane	C205	1P/S	965	1,000	I
Stationair 6, Turbo Stationair 6	C206	1P/S	975	1,000	I
Stationair/Turbo Stationair 7/8	C207	1P/S	810	1,000	I
Caravan 1- 208, (Super) Cargomaster, Grand Caravan (U27)	C208	1T/S	1,400	1,400	I
Centurion 210, Turbo	C210	1P/S	900	1,000	I

Centurion					
Pressurized Centurion	P210	1P/S	1,000	1,000	I
Crusader 303	C303	2P/S	3,500	3,000	II
Cessna 310/Riley 65, Rocket	C310	2P/S	2,800	2,000	II
Skyknight 320	C320	2P/S	2,900	2,000	II
Cessna 335	C335	2P/S	2,200	2,000	II
Skymaster 336	C336	2P/S	1,340	1,340	II
Super Skymaster 337	C337	2P/S	1,250	1,500	II
Pressurized Skymaster T337G, P337	P337	2P/S	1,250	1,500	II
Cessna 340	C340	2P/S	2,900	2,000	II
Cessna 401, 402, Utiliner, Businessliner	C402	2P/S	2,500	2,000	II
Titan 404	C404	2P/S	2,600	2,000	II
Caravan 2 - F406	F406	2T/S	1,850	-	II
Cessna 411	C411	2P/S	2,800	2,000	II
Chancellor 414, Rocket Power	C414	2P/S	2,300	2,000	II
Golden Eagle 421	C421	2P/S	3,200	2,000	II
Corsair/Conquest I-425	C425	2T/S	3,500	2,500	II
Conquest/Conquest 2 - 441	C441	2T/S	4,200	3,000	II
Citation 1	C500	2J/S	3,100	3,500	III
Citation 1-SP	C501	2J/S	4,300	3,000	III
Citationjet C525	C525	2J/S	3,000	-	III
Citationjet C526	C526	2J/S	3,000	-	III
Citation 2/-S2	C550	2J/S+	5,300	3,000	III
Citation 2-SP	C551	2J/S	5,300	3,000	III
Citation 5	C560	2J/S+	6,000	3,500	III
Citation 3/6/7	C650	2J/S+	3,900	4,000	III
Citation 10	C750	2J/S+	3,500	3,500	III
Bird Dog 305/321	O1	1P/S	1,150	1,150	I
Cessna 318	T37*	2J/S	3,000	3,000	III

CHAMPION (USA-see Bellanca Aircraft)

CONSTRUCCIONES AERONAUTICAS (CASA) (Spain)

(Also NURTANIO, NUSANTARA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
C-212 Aviocar	C212	2T/S+	900	900	III

CHRISTEN INDUSTRIES, INC. (USA)

(Also AVIAT)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
A-1 Huskey	HUSK	1P/S	1,500	1,500	I

COLEMILL (USA) (See BEECH, PIPER, CESSNA)

CURTIS-WRIGHT CORP. (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Commando C-46 (CW-20)	C46	2P/L	600	700	III

DASSAULT-BREGUET (France)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Falcon 10, Mystere 10	FA10	2J/S+	2,300	1,600	III
Falcon 20, Mystere 20 (T-11)	FA20	2J/S+	2,000	2,200	III
Falcon 50, Mystere 50 (T-16)	FA50	3J/S+	1,800	1,600	III

Falcon 900, Mystere 900 (T-18)	F900	3J/L	2,000	1,700	III
Falcon 2000	F2TH	2J/S+	2,500	1,500	III

DEHAVILLAND (Canada/UK)

(Also AIRTECH, HAWKER-SIDDELEY, OGMA, RILEY, SCENIC)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Comet DH-106	COMT	4J/L	2,900	2,000	III
Chipmunk DHC-1	DHC1	1P/S	900	1,000	I
Beaver DHC-2	DHC2	1P/S	840	1,000	I
Turbo Beaver DHC-2T	DH2T	1T/S	1,220	1,000	I
Otter DHC-3	DHC3	1P/S	750	1,000	I
Caribou DHC-4	DHC4	2P/S+	1,350	1,000	III
Buffalo DHC-5D/E	DHC5	2T/L	2,000	1,500	III
Twin Otter DHC-6 (all series)	DHC6	2T/S	1,600	1,800	II
Dash 7 DHC-7	DHC7	4T/L	4,000	4,000	III
Dash 8, DHC8 - 100	DH8A	2T/L	1,500	1,500	III
Dash 8, DHC8 - 200	DH8B	2T/L	1,500	1,500	III
Dash 8, DHC8 - 300	DH8C	2T/L	1,500	1,500	III
Dash 8, DHC8 - 400	DH8D	2T/L	2,500	2,500	III
Dove DH-104	DOVE	2P/S	1,420	1,420	II
Heron DH-114	HERN	4P/S+	1,075	1,075	III

DIAMOND (Canada)

(Also HOAC)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
DV-20 Katana, DA-22 Speed Katana	DV20	1P/S	730	-	I

DORNIER GmbH (FRG)

(Also CASA, HINDUSTAN)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Do 228-100/200 Series	D228	2T/S+	2,000	2,000	III
Do 328 Series	D328	2T/S+	2,000	2,000	III
Do 27	DO27	1P/S	700	800	I
Do 28 A/B (Agur)	DO28	2P/S	1,500	1,500	II
Do 28D/D-1/ D-2, 128-2 Skyservant	D28D	2P/S	1,000	-	II
Do-28D-6, 128-6 Turbo Skyservant	D28T	2T/S	1,500	-	II

EMBRAER (Brazil)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Bandeirante EMB-110/111	E110	2T/S+	1,500	1,500	II
Brasilia EMB-120	E120	2T/S+	2,300	2,300	III
EMB-145	E145	2J/L	2,350	-	III

EXTRA (Germany)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Extra 200	E200	1P/S	1,000	1,000	I
Extra 230	E230	1P/S	1,500	1,500	I
Extra 300, 350	E300	1P/S	2,500	1,500	I
Extra 400	E400	1P/S	1,500	1,500	I

FAIRCHILD INDUSTRIES (USA-includes Swearingen Aviation)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Thunderbolt II	A10*	2J/L	6,000	5,000	III
Flying Box Car	C119	2P/L	750	750	III
Provider	C123	2P/L	890	1,000	III
Friendship F27, F227, Troopship, Maritime, Firefighter	F27	2T/L	3,000	3,000	III
Cornell	FA62	1P/S	650	650	I
Pilatus/Peacemaker/ Porter	PC6P	1P/S	580	600	I
Turbo Porter	PC6T	1T/S	580	600	I
Merlin 2	SW2	2T/S	2,350	2,500	II
Merlin 3	SW3	2T/S+	2,350	2,500	III
Metro, Merlin 4	SW4	2T/S+	2,400	2,500	III

FOKKER BV (Netherlands)

(Also FAIRCHILD, FAIRCHILD-HILLER)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Friendship F27, Troopship, Maritime, Firefighter	F27	2T/L	3,000	3,000	III
Fellowship F28	F28	2J/L	4,650	2,000	III
Fokker 50, Maritime Enforcer	F50	2T/L	3,500	3,500	III
Fokker 60	F60	2T/L	3,500	3,500	III
Fokker 70	F70	2J/L	4,500	3,000	III
Fokker 100	F100	2J/L	3,500	3,500	III

GATES LEARJET CORP. (USA)

(Also LEAR JET, LEARJET, SHIN MEIWA)

Model	Type	Description	Performance

		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Learjet 23	LJ23	2J/S	4,500	4,000	III
Learjet 24	LJ24	2J/S+	4,500	4,000	III
Learjet 25	LJ25	2J/S+	4,500	4,000	III
Learjet 28, 29	LJ28	2J/S+	4,500	4,000	III
Learjet 31	LJ31	2J/S+	4,500	4,000	III
Learjet 35, 36	LJ35	2J/S+	4,500	4,000	III
Learjet 55	LJ55	2J/S+	5,000	4,000	III
Learjet 60	LJ60	2J/S+	5,000	4,000	III

GENERAL DYNAMICS CORP. (USA)

(Also BOEING CANADA, CANADAIR, CANADIAN VICKERS, CONSOLIDATED, CONVAIR, FOKKER, KELOWNA, LOCKHEED, LOCKHEED MARTIN, MITSUBISHI, SABCA, SAMSUNG, TUSAS)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Canso/Catalina***	CAT	2P/S+	600	600	III
Convair 990	CV99	4J/L	2,500	2,500	III
Convair 240/340/440, Liner, Samaritan	CVLP	2P/L	1,000	800	III
Convair 540/580/600/640	CVLT	2T/L	1,500	1,500	III
F-111/FB-111	F111*	2J/L	5,000	5,000	III
Fighting Falcon	F16*	1J/L	8,000	5,000	III
Valiant	VALI	1P/S	600	750	I

GOVERNMENT AIRCRAFT FACTORIES (Australia) (Now GAF)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
N2/22/24 Nomad	NOMA	2T/S	1,300	1,100	II

GREAT LAKES (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Sport Trainer, Sport, 2T-1	G2T1	1P/S	1,000	800	I

GROB (Germany)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
G109 Ranger (Vigilant)	G109	1P/S	600	600	I
G115 A/B/C/D, Bavarian (Heron)	G115	1P/S	1,200	1,100	I

GRUMMAN AEROSPACE CORP. (USA)

(Also AERO MOD, AMERICAN GENERAL, GRUMMAN AMERICAN, GULFSTREAM AMERICAN, MID-CONTINENT, NORTHROP GRUMMAN, SERV-AERO)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Intruder, Prowler	A6*	2J/L	7,500	5,000	III
AA1 Trainer, Yankee, TR/TS-2, T-Cat, Lynx	AA1	1P/S	850	1,250	I
Cheetah AA-5, Traveller, Tiger	AA5	1P/S	660	1,000	I
Greyhound	C2	2T/L	1,000	2,200	III
Hawkeye, Daya	E2	2T/L	2,690	3,000	III
Tomcat	F14*	2J/L	6,000	4,000	III
Model G-164 Ag-Cat, Super Ag-Cat, King Cat	G164	1P/S	1,500	1,500	I
Model G164 Turbo Ag-Cat	G64T	1T/S	1,500	1,500	I
Goose/Super Goose	G21	2P/S+	1,000	1,000	III
Widgeon/Super Widgeon	G44	2P/S+	1,000	1,500	III
Mallard***	G73	2P/S+	1,600	1,600	III

Cougar GA-7	GA7	2P/S	1,600	1,500	II
Albatross***	U16	2P/S+	1,500	1,500	III
Mohawk	V1	2T/S+	2,100	1,300	I

GULFSTREAM AEROSPACE CORP. (USA)

(Also GRUMMAN, GRUMMAN AMERICAN, GULFSTREAM, GULFSTREAM AMERICAN)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
GAC 159-C, Gulfstream 1	G159	2T/S+	2,000	2,000	III
Gulfstream 2	GLF2	2J/L	5,000	4,000	III
Gulfstream 3	GLF3	2J/L	5,000	4,000	III
Gulfstream 4	GLF4	2J/L	5,000	4,000	III
Gulfstream 5	GLF5	2J/L	5,000	4,000	III

HAMBURGER FLUGZEUBAU (FRG) (Now HFB)

(Also MBB)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
HFB-320 Hansajet	HF20	2J/S+	4,500	4,500	III

HANDLEY PAGE (UK)

(Also BRITISH AEROSPACE, JETSTREAM, SCOTTISH AVIATION, VOLPAR)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
HP-137 Jetstream 1	JS1	2T/S+	2,200	2,200	III
HP-137 Jetstream 200	JS20	2T/S+	2,200	2,200	III

HAMILTON AVIATION (USA)

(Also VOLPAR)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Westwind 2/3, Turbo 18, Turboliner	B18T	2T/S	2,000	2,000	II

HELIO AIRCRAFT COMPANY (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Courier, Strato-Courier, Super Courier (H-391/392/395/ 250/295/700/800)	COUR	1P/S	850	1,000	I
H-550/A Stallion	STLN	1T/S	2,200	2,200	I
H-580 Twin Courier	TCOU	2P/S	1,250	1,500	II

HOWARD (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
DG-15P, -15W, -15J	DG15	1P/S	1,000	1,000	I

ILYUSHIN (USSR)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
IL-62	IL62	4J/H	3,500	2,500	III
IL-76/78	IL76	4J/H	3,000	2,500	III

ISRAEL AIRCRAFT INDUSTRIES (Israel)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
101 Avara, 102, 201, 202	ARVA	2T/S+	1,300	1,000	III
1123 Westwind	WW23	2J/S+	4,000	3,500	III
1124 Westwind	WW24	2J/S+	4,000	3,500	III

ISRAEL AIRCRAFT INDUSTRIES & ASTRA JET (Israel/USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Astra 1125	ASTR	2J/S+	4,000	3,500	III

JETSTREAM (UK - see British Aerospace)

LAKE AIRCRAFT (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
LA-250/270 (Turbo) Renegade/(Turbo) SeaFury***, Seawolf	LA25	1P/S	700	700	I
LA-4/200, Buccaneer***	LA4	1P/S	1,100	1,000	I

LOCKHEED CORP. (USA)

(Also AERITALIA, CANADAIR, FIAT, FOKKER, HOWARD, LEAR, LOCKHEED-MARTIN, MBB, MESSERSCHMITT, MITSUBISHI, PACAERO, ROCKWELL, SABCA)

Model	Type Designator	Description	Performance Information		
		Number & Type	Climb Rate	Descent Rate	SRS Cat.

		Engines/Weight Class	(fpm)	(fpm)	
Hercules, Spectre	C130	4T/L	1,500	1,500	III
C-141 Starlifter	C141	4J/H	3,500	3,000	III
C-5 Galaxy	C5	4J/H	2,500	2,000	III
Constellation, Super Constellation, Starliner (L-049/749/1049/ 1649)	CONI	4P/L	1,700	1,700	III
F-104 Starfighter	F104*	1J/L	5,000	4,000	III
L-1011 Tri-Star (all series)	L101	3J/H	3,500	3,000	III
Lodestar	L18	2P/L	1,800	2,000	III
Electra 188	L188	4T/L	1,850	2,000	III
1329 Jetstar 6/8	L29A	4J/L	4,000	3,500	III
1329-5 Jetstar 2/731	L29B	4J/L	4,000	3,000	III
Orion, Aurora (L-185/285/685/ 785)	P3	4T/L	1,850	2,000	III
Viking S-3	S3	2J/L	2,000	2,000	III
T-33, T-Bird, F-80 Shooting Star	T33*	2J/L	2,000	2,000	III
TR-1 Trigull	TR1*	1J/L	6,000	6,000	III
U-2	U2*	1J/S+	6,000	6,000	III

MARTIN COMPANY (Division of Martin Marietta) (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Martin 404	M404	2P/L	1,600	1,500	III

MAULE AIRCRAFT CORP. (USA)

(Also SAASA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
M-4 Strata-Rocket,	M4	1P/S	1,000	1,000	I

Astro Rocket, Bee-Dee, Jetasen, Super Rocket					
M-5 180C/200/235C Lunar-Rocket, 210TC Strata-Rocket, Patroller	M5	1P/S	1,000	1,000	I
M-6 Super-Rocket	M6	1P/S	1,500	1,000	I
M-7-235, MT-7, MX-7-160/ 180/235, MXT-7-160/ 180 Super Rocket, Star Rocket	M7	1P/S	825	-	I
M-7-420, MX-7-420, MXT-7-420 Star Craft	M7T	1T/S	4,500	-	I

MCDONNELL-DOUGLAS CORP. (USA)

(Also ASTA, DOUGLAS, GAF, LISUNOV, MITSUBISHI, ON MARK, SHANGHAI, VALMET)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Skywarrior	A3*	2J/L	5,000	6,000	III
Skyhawk	A4*	1J/L	5,000	5,000	III
Invader	B26	2P/L	1,000	1,000	III
Globemaster 3	C17	4J/H	-	-	III
DC-10 (all series)	DC10	3J/H	2,400	2,000	III
Skytrain (C-47, C-53, C-117 A/B/C, R4D 1 to 7)	DC3	2P/S+	1,200	1,200	III
Super DC-3 (C-117D, R4D 8)	DC3S	2P/S+	1,330	1,330	III
Skymaster	DC4	4P/L	2,300	2,300	III
DC-6/B Liftmaster	DC6	4P/L	1,000	1,000	III
DC-7/B/C Seven Seas	DC7	4P/L	1,250	1,250	III
DC-8-50, Jet Trader	DC85	4J/H	4,000	4,000	III
DC-8-60	DC86	4J/H	4,000	4,000	III
DC-8-70	DC87	4J/H	5,000	4,000	III
DC-8 Stage 3	DC8Q	4J/H	4,000	4,000	III

DC-9, Skytrain 2, Nightingale	DC9	2J/L	3,000	3,000	III
DC-9 Stage 3	DC9Q	2J/L	3,000	3,000	III
F-15 Eagle	F15*	2J/L	8,000	5,000	III
F/A-18 Hornet	F18	2J/L	8,000	6,000	III
Phantom 2	F4*	2J/L	8,000	6,000	III
MD-11	MD11	3J/H	-	-	III
MD-80 Series	MD80	2J/L	3,500	3,000	III
MD-90	MD90	2JL	-	-	III

MESSERSCHMITT-BOLKOW-BLOHM (MBB) (FRG)

(Also BOLKOW, HFB, NORD)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
BO 209 Monsun	B209	1P/S	1,100	1,100	I
HFB 320 Hansa Jet	HF20	2J/S+	3,500	3,000	III
ME 108 Taifun	ME08	1P/S	400	500	III

MITSUBISHI AIRCRAFT INTERNATIONAL INC. (USA/Japan)

(Also BEECH, RAYTHEON)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Mitsubishi MU-2, Marquise, Solitaire	MU2	2T/S	3,500	3,000	II
Mitsubishi Diamond I/MU-300	MU30	2J/S+	3,500	4,000	III

MOONEY AIRCRAFT CORP. (USA)

(Also AEROSTAR)

Model	Type Designator	Description	Performance Information		

		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
M-18 Mooney Mite, Wee Scotsman	MITE	1P/S	750	750	I
Mark 10 Cadet	M10	1P/S	800	800	I
M20/A/B/C/D/E/ F/G/J/L/R, Mark 21, Ranger, Master, Super 21, Chaparral, Executive, Statesman, Ovation, 201, 205, ATS, MSE, PFM	M20P	1P/S	1,000	1,000	I
Turbo Mooney M20K/M20M, Encore, 231, 252, TLS, TSE	M20T	1P/S	1,500	1,200	I
Mark 22, Mustang	M22	1P/S	1,300	1,300	I

MUDRY (See AVIONS MUDRY ET CIE)

NAMC (Japan)

(Also MITSUBISHI)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
YS-11	YS11	2T/L	1,500	1,500	III

NAVION RANGEMASTER AIRCRAFT CORP. (USA)

(Also CAMAIR, RILEY, TEMCO)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Rangemaster	RANG	1P/S	1,250	1,500	I
Twin Navion 480, 55	TNAV	2P/S	1,800	1,500	II

NOORDYUN AVIATION LTD. (Canada)

(Also CCF)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Norseman Mk 4/5/6	NORS	1P/S	700	1,000	I

NORD AVIATION (Affiliate of Aerospatiale) (France)

(Also HOLSTE, NORDFLUG, TRANSALL)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Transall C-160	C160	2T/L	2,000	2,000	III
Super Broussard 260	N260	2T/S+	2,500	2,000	III
Mohawk 298, Fregate	N262	2T/S+	2,500	2,000	III
Nortatlas 2501 to 2508	NORA	2P/L	1,500	1,500	III

NORTHERN AVIATION (USA-see Bellanca)

NORTHROP CORP. (USA)

(Also CANADAIR, CASA, AIDC, F+W EMMEN, KOREAN AIR)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Freedom Fighter Tiger II	F5*	2J/S+	8,000	5,000	III
T-38 Talon	T38*	2J/S+	8,000	5,000	III

PARTENAVIA CONSTRUZIONI AERONAUTICHE SpA (Italy)

Model	Type Designator	Description	Performance Information		
		Number & Type	Climb	Descent Rate	SRS Cat.

		Engines/Weight Class	Rate (fpm)	(fpm)	
P66/64 Charlie, Oscar	OSCR	1P/S	800	1,000	I
P68/B/C/-TC, Victor, Observer/P68R	P68	2P/S	1,200	1,000	I

PARTENAVIA & AERITALIA (Italy)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
AP68TP-300 Spartacus	P68T	2T/S	1,500	1,500	II
AP68TP-600, Viator	VTOR	2T/S	1,500	1,500	II

PIAGGIO (Industrie Aeronautiche E Meccaniche Rinaldo Piaggio SpA) (Italy)

(Also PIAGGIO-DOUGLAS, TRECKER)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
P136 Gull***	P136	2P/S	1,250	1,500	II
P166 Portofino***, Albatross	P66P	2P/S	1,350	1,500	II
Vespa Jet PD808	P808	2J/S+	4,000	3,500	III

PILATUS FLUGZEUGWERKE AG (Switzerland)

(Also FAIRCHILD, FAIRCHILD-HILLER)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
PC-6 Porter	PC6P	1P/S	600	600	I
PC-6A/B/C Turbo Porter	PC6T	1T/S	1,250	1,500	I
PC-7 Turbo Trainer	PC7	1T/S	2,800	-	I

PIPER AIRCRAFT CORP. (USA)

(Also AEROSTAR, AICSA, CHINCUL, COLEMILL, EMBRAER, INDAER CHILE, JOHNSTON, MACHEN, MILLER, NIEVA, SCHAFER, SEGUIN, PZL-MIELEC, TED SMITH, WAGAERO)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Aero Star 600/700	AEST	2P/S	1,500	1,500	II
J-2 Cub	J2	1P/S	500	500	I
J-3 Cub	J3	1P/S	500	500	I
J-4 Cub Coupe	J4	1P/S	500	500	I
J-5 Cub Cruiser	J5	1P/S	500	500	I
Cub Special	PA11	1P/S	500	500	I
Super Cruiser	PA12	1P/S	600	600	I
Family Cruiser	PA14	1P/S	600	600	I
Vagabond Trainer	PA15	1P/S	500	500	I
Clipper	PA16	1P/S	500	500	I
Vagabond	PA17	1P/S	500	500	I
Super Cub	PA18	1P/S	1,000	1,000	I
Pacer	PA20	1P/S	850	1,000	I
Tri-Pacer, Colt, Caribbean	PA22	1P/S	1,000	1,000	I
Apache 150/160	PA23	2P/S	1,050	1,000	II
Comanche	PA24	1P/S	900	1,000	I
Pawnee	PA25	1P/S	650	650	I
Aztec, Turbo Aztec	PA27	2P/S	1,500	1,500	II
Cherokee, Archer, Warrior, Cadet, Cruiser (PA-28-140/ 150/151/160/161/ 180/181)	P28A	1P/S	750	1,000	I
Dakota, Turbo Dakota, Charger, Pathfinder (PA-28-201T/ 235/236)	P28B	1P/S	900	1,000	I
Cherokee Arrrow 2/3, Turbo Arrow 3	P28R	1P/S	750	1,000	I
Cherokee Arrow 4, Turbo Arrow 4	P28T	1P/S	900	1,000	I

Twin Comanche, Turbo Twin Comanche	PA30	2P/S	1,500	1,500	II
Chieftan, Mohave, Navajo, T-1020	PA31	2P/S	1,500	1,500	II
Cherokee Six, Lance, (Turbo) Saratoga	PA32	1P/S	850	1,000	I
Cherokee Lance PA-32R, Saratoga SP, Turbo Saratoga SP	P32R	1P/S	850	1,000	I
Lance 2, Turbo Lance 2	P32T	1P/S	850	1,000	I
Seneca 2/3	PA34	2P/S	1,300	1,300	II
Brave, Pawnee Brave, Super Brave	PA36	1P/S	800	1,000	I
Tomahawk	PA38	1P/S	750	750	I
Seminole, Turbo Seminole	PA44	2P/S	1,100	1,000	II
Malibu, Malibu Mirage	PA46	1P/S	1,000	1,000	I
Malibu Meridian	P46T	1T/S	1,500	1,500	I
T-1040	PAT4	1P/S	1,300	1,200	I
Cheyenne 1	PAY1	2T/S	2,200	2,000	II
Cheyenne 2	PAY2	2T/S	2,400	2,000	II
Cheyenne 3	PAY3	2T/S	2,400	2,000	II
Cheyenne 400	PAY4	2T/S	2,500	2,000	II
Pillan PA-28R-300	PILL	1P/S	750	1,000	I
Voyager, Station Wagon 108	S108	1P/S	800	800	I

PITTS AEROBATICS (Manufactured by Christen Industries, Inc.)(USA)

(Also AEROTEK, AVIAT, CHRISTEN)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
S-1 Special	PTS1	1P/S	1,500	1,500	I
S-2 Special	PTS2	1P/S	1,500	1,500	I

RAYTHEON (See BEECH)

RILEY AIRCRAFT CORP. (USA)

(Also AVIONES, COLOMBIA, CESSNA, COLEMILL)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
M65 Rocket, Turbo Rocket, Super 310	C310	2P/S	1,500	1,500	II

ROCKWELL INTERNATIONAL CORP. (USA)

(Also AERO COMMANDER, CANADAIR, CCF, COMMANDER, COMMONWEALTH, GULFSTREAM, HAMILTON, MITSUBISHI, NOORDUYN, NORTH AMERICAN PACAERO, PACIFIC AIRMOTIVE, ROCKWELL, RYAN, SUD, TUSCO)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Commander 112/114	AC11	1P/S	1,000	1,200	I
Commander 500	AC50	2P/S	1,340	1,500	II
Commander 520	AC52	2P/S	1,340	1,500	II
Commander 560	AC56	2P/S	1,400	1,500	II
Super Commander 680S/E/F/FP	AC68	2P/S	1,375	1,375	II
Grand Commander 685/680FL	AC6L	2P/S	1,250	1,250	II
Alti-Cruiser	AC72	2P/S	1,300	1,300	II
Turbo Commander 680/681 Hawk Commander	AC80	2T/S	2,000	1,500	II
Turbo Commander 690, Commander Jetprop 840/900	AC90	2T/S	2,500	2,500	II
Turbo Commander 695, Commander Jetprop 980/1000	AC95	2P/S	2,500	2,500	II

Lancer	B1*	4J/H	3,000	5,000	III
Mitchell	B25	2P/L	980	980	III
Sabre	F86*	1J/L	4,000	4,000	III
Jet Commander 1121	JCOM	2J/S+	5,000	4,500	III
Lark 100 Commander	LARK	1P/S	700	1,000	I
Commander 200	M200	1P/S	1,400	1,000	I
Navion NA 145/154	NAVI	1P/S	750	600	I
Mustang	P51	1P/S	2,500	2,500	III
Sabreliner 65/40/50/60	SBR1	2J/S+	4,000	3,500	III
Super Sabre F-100	SSAB	1J/L	4,000	4,000	III
Buckeye	T2*	2J/L	5,700	6,000	III
Trojan, Nomair, Nomad	T28	1P/S	2,500	2,500	III
Texan, Harvard	T6	1P/S	800	800	I
Bronco	V10*	2T/S	2,000	2,500	II
Darter 100	VO10	1P/S	850	850	I

RUSHCMEYER (Germany)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
R90R-90-230FG	R90F	1P/S	1,000	1,000	I
R90R-90-230RG, MF-85	R90R	1P/S	1,000	1,000	I

SAAB & FAIRCHILD INDUSTRIES (Sweden/USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
SF-340	SF34	2T/L	2,000	2,000	III

SHORT BROTHERS LTD. (UK)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Shorts SC7 Skyvan, Skyliner	SC7	2T/S	1,500	1,500	II
Shorts 330, Sherpa	SH33	2T/S+	1,380	1,380	III
Shorts 360	SH36	2T/S+	1,400	1,400	III

SIAI MARCHETTI SpA (Italy)

(Also AGUSTA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
SF260TP	F26T	1T/S	1,800	1,100	I
F600, SF-600TP Canguero	F600	2T/S	2,100	-	II

SILVAIRE (USA)

(Also LUCSOME, TEMCO)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Luscombe Silvaire	L8	1P/S	900	1,000	I

SOCATA (See AEROSPATIALE)

STINSON (USA)

(Also PIPER)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.

Sentinel V-76, L-5, U-19, OY	L5	1P/S	750	750	I
Reliant (Vultee) V-77	RELI	1P/S	700	700	I
Voyager 10/105	S10	1P/S	750	1,000	I
Voyager/Station Wagon 108	S108	1P/S	750	1,000	I

SUD AVIATION (See Aerospatiale)

SWEARINGEN AVIATION (USA-see Fairchild Industries)

TAYLORCRAFT AVIATION CORP. (USA)

(Also TAYLOR KITS)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
F-15 Tourist, Foursome	TA15	1P/S	800	1,000	I
F-19 Sportsman	TF19	1P/S	800	1,000	I
F-20A Topper, Ranchwagon, Seabird, Zephyr	TA20	1P/S	1,000	1,000	I
F-21, T-Kraft	TF21	1P/S	1,100	1,100	I

TED SMITH AEROSTAR CORP. (USA)

(Also AEROSTAR, AICSA, MACHEN, PIPER)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Aero Star	AEST	2P/S	1,800	1,500	II

VFW-FOKKER (Zentralgesellschaft VFW-Fokker mbH (FRG/Netherlands))

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
VFW 614	VF14	2J/L	3,100	3,000	III

VOUGHT CORP. (USA)

(Also GLOBE, LTV, TEMCO)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Corsair A-7, TA-7, EA-7	A7*	1J/L	8,000	6,000	III
Swift	GC1	1P/S	1,000	1,000	I

ZENAIR (Canada)

(Also ZENITH)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
CH-2000 Zenith	CH2T	1P/S	780	-	I

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Appendix B.

Aircraft Information

Helicopters/Rotorcrafts

TYPE ENGINE ABBREVIATIONS

P	piston
T	jet/turboprop
J	jet

CLIMB AND DESCENT RATES

Climb and descent rates based on average en route climb/descent profiles at median weight between maximum gross takeoff and landing weights.

SRS

SRS means "same runway separation;" categorization criteria is specified in para 3-9-6, Same Runway Separation.

MANUFACTURERS

Listed under the primary manufacturer are other aircraft manufacturers who also make versions of some of the aircraft in that group.

AEROSPATIALE (France)

(Also ATLAS, CASA, CHANGHE, EUROCOPTER, HELIBRAS, HINDUSTAN, IAR, ICA, NURTANIO, NUSANTARA, REPUBLIC, SINGAPORE, SUD, WESTLAND)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Lama SA-315	LAMA	1T/S	1,000	1,000	I
Alouette 2	ALO2	1T/S	1,280	1,280	I
Alouette 3	ALO3	1T/S	1,500	1,500	I
Dauphine SA-360/361	S360	1T/S	1,400	1,500	I
Dauphine 2 SA-365C	S65C	2T/S	1,800	1,000	I
Ecurevil/AStar	AS50	1T/S	1,000	1,000	I

AS-350/550					
Gazelle SA-341/342	GAZL	1T/S	1,620	1,620	I
Puma SA-330 (CH-33, HT-19)	PUMA	2T/L	1,250	1,500	I
Super Puma AS 332/532, SA-330)	AS32	2T/L	1,250	1,500	I
Super Frelon SA-321/Z-8	FREL	3T/L	1,200	1,500	I
Twin Star AS-355/555	AS55	2T/S	1,350	1,300	I

AUGUSTA (Constuzioni Aeronautiche Giovanni Agusta SpA) (Italy)

(Also BELL, NUSANTARA, SABCA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Model 147J-3B-1, Ranger	B47J	1P/S	500	500	I
Model A 109/A/A-II	A109	2T/S	1,620	1,500	I
Model 212 ASW, Griffon	B12	2T/S	1,420	1,420	I

BELL/BOEING

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Osprey	V22	2P/L	-	-	II

BELL HELICOPTER TEXTRON (USA)

(Also AGUSTA, AIDC, COMMONWEALTH, DORNIER, FUJI, GLOBAL, KAWASAKI, NUSANTARA, TROOPER, UNC, WESTLAND)

Model	Type Designator	Description	Performance

			Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Biglifter, Bell 204, 205, 214A/B, AB-204	UH1	1T/S	1,500	1,500	I
Cobra	HUCO	1T/S	1,375	1,375	I
Jet Ranger/ Long Ranger/ Sea Ranger/ Kiowa/ Model 206, Combat Scout	B06	1T/S	1,200	1,000	I
Huey/Iroquois/ Model 205 A-1	UH1	1T/S	1,500	1,500	I
Ranger Model 47J	B47J	1P/S	1,000	1,000	I
Sioux/Model 47**G**, OH-13	B47G	1P/S	1,000	1,000	I
Twin Huey, Model 212, Model 214B/ B-1, Model 412, Griffon	B12	2T/S	1,420	1,420	I
Model 214ST, Super Transport	BSTP	2T/S	1,420	1,420	I
Model 222, 230, 430	B222	2T/S	1,500	1,000	I

BOEING VERTOL COMPANY (USA)

(Also BOEING HELICOPTERS, KAWASAKI, MERIDIONALI, VERTOL)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Chinook, Model 234	H47	2T/L	1,500	1,500	I
Sea Knight 107, CH-113, Labrador	H46	2T/S+	2,130	2,130	I

BOLKOW (Germany)

(Also CASA, EUROCOPTER, MBB, MESSERSCHMITT-BOLKOW, NURTANIO, NUSANTARA, PADC)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Model 105, BO-105	B105	2T/S	1,500	1,500	I

BRANTLEY-HYNES HELICOPTER, INC. (USA)

(Also BRANTLEY, HYNES)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Model B-2/A/B, H-2	BRB2	1P/S	1,400	1,400	I
Model 305	B305	1P/S	1,300	1,300	I

ENSTROM CORP. (USA)

(Also WUHAN)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Falcon/Model F-28/A/C/F, Sentinel/ Model F-28-FP, Model 280, Shark	EN28	1P/S	800	800	I
Shark/Model 280FX, 28, Falcon, Sentinel	EN28	1P/S	1,200	1,200	I
Turbo Shark 480, TH-28	EN48	1P/S	1,500	1,500	I

FAIRCHILD/REPUBLIC (includes Hiller) (USA)

(Also FAIRCHILD HILLER, ROGERSON HILLER)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Hiller UH-12/ Raven, HTE	UH12	1P/S	1,500	1,500	I

HILLER (See FAIRCHILD/REPUBLIC (USA))

HUGHES HELICOPTERS (See MCDONNELL-DOUGLAS HELICOPTERS (USA))

KAMAN AEROSPACE CORPORATION (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
H-2 Seasprite, Super Seasprite	H2	2T/L	2,400	2,400	I
Huskie 600-3/5	H43B	1T/L	2,000	2,000	I

KAWASAKI HEAVY INDUSTRIES LTD. (Japan)

(Also BOEING VERTOL, VERTOL)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
KV-107/II, Sea Knight, Labrador, Voyaguer, CH-113	H46	2T/S+	1,500	1,500	I

MCDONNELL-DOUGLAS HELICOPTERS (includes Hughes Helicopters) (USA)

(Also AGUSTA, BREDANARDI, KAWASAKI, KOREAN AIR, NARDI, RACA, SCHWEIZER)

Model	Type Designator	Description	Performance Information		
		Number & Type	Climb	Descent Rate	SRS

		Engines/Weight Class	Rate (fpm)	(fpm)	Cat.
Model 77/ Apache, Pethen, Longbow Apache	H64	2T/S+	1,500	1,500	I
Model 269, 200, 280, 300, Skynight, TH-55 Osage	H269	1P/S	1,000	1,000	I
Model 300/C	H269	1P/S	1,200	1,200	I
Model 500C, 369, 530F, Defender, Black Tiger, Night Fox, Lifter	H500	1P/S	1,500	1,500	I
Osage	H269	1P/S	1,000	1,000	I
Pawnee, Model 369, Model 500D/MD/MG	H500	1T/S	1,500	1,500	I

MESSERSCHMIDTT-BOLKOW-BLOHM (MBB) (FRG)

(Also BOLKOW, CASA, EUROCOPTER, MBB, NURTANIO, NUSANTARA, PADC)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Model BO 105	B105	2T/S	1,200	1,200	I

MBB/KAWASAKI (FRG/Japan)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Model BK 117	BK17	2T/S	1,500	1,500	I

ROBINSON HELICOPTER COMPANY INC. (USA)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.

Model R22	R22	1P/S	800	800	I

SCHWEIZER AIRCRAFT CORP. (USA)

(Also BREDANARDI, HUGHES, KAWASAKI, NARDI)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Model 269C, 200, 280, 300, Skynight	H269	1P/S	1,000	1,000	I

SIKORSKY AIRCRAFT (USA)

(Also AGUSTA, ASTA, HAWKER DE HAVILLAND, HELIPRO, KOREAN AIR, MITSUBISHI, TUSAS, UNITED CANADA, VAT, WESTLAND)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
Blackhawk S-70, WS-70, Seahawk, Pavehawk, Rescuehawk, Thunderhawk, Jayhawk, Oceanhawk, Deserthawk, Yanshuf, LAMPS MK3, Blackhawk	H60	2T/S+	2,000	2,000	I
Chickasaw S-55, H-19, HO4S, HRS	S55P	1P/S	800	1,000	I
Choctaw/ Seashore/ Seaboat S-58, CH-34	S58P	1P/L	1,120	1,120	I
Model S-51	S51	1P/L	1,000	1,000	I
Model S-52, Hummingbird	S52	1P/L	950	1,000	I
Model S-62	S62	1T/S	1,020	1,000	I

Model S-76, Spirit, Eagle	S76	2T/S	1,300	1,300	I
S-61R (CH-3, HH-3, Pelican)	S61R	2T/L	1,500	1,500	I
S-61A/B/D/L/N Sea King, Commando, CH-124	S61	2T/L	1,500	1,500	I
Sea Stallion S-65, Yasur	H53	2T/L	1,500	1,500	I
Skycrane S-64E/F, Tarhe S-64	S64	2T/L	1,300	1,300	I

WESTLAND HELICOPTERS LTD. (UK)

Model	Type Designator	Description	Performance Information		
		Number & Type Engines/Weight Class	Climb Rate (fpm)	Descent Rate (fpm)	SRS Cat.
WG 30	WG30	2T/S	1,200	1,200	I

Return to ATC Home Page	Go back to Appendix A	Go to Appendix C	Back to Top of this Page

CHAPTER 1
INTRODUCTION

1-1. PURPOSE, SCOPE, ARRANGEMENT.

a. The Purpose of this manual is: to provide fire protection, support organizations, and other, either military or civilian, whose duties are related directly or indirectly to the performance of aerospace emergency rescue and mishap response with uniform and chronologically assembled information.

b. The Scope and Arrangement of this manual is: basically two-fold; first to provide general information in Chapter 2, Hazardous Materials and Mishap Hazards in Chapter 3, and specific information on US Air Force aircraft in Chapters 4 through 12, US Army aircraft in Chapters 13 through 16, selected Commercial aircraft in Chapter 17 and US Navy/Marine aircraft in Chapters 18 through 23. NATO aircraft chapters will encompass Chapters 24 through 34. Other chapters may follow to include other weapon systems. Chapter 2 includes general aircraft characteristics with regard to entry and exit facilities; prevention of suffocation; removal of personnel from seats; types, safetying and hazards of ejection seats; and forcible entry. Chapters 4 through the remainder of the publication include, as applicable to a given aircraft, the following information:

c. General Arrangement Information:

(1) Overall Description.

(2) Color Code Legend.

(a) Blue - Fuel (tanks/cells/lines), quantity in US gallons/litres, and location.

(b) Red - Skin penetration, armament, flare and chaff dispensers, controls, switches, door/hatch cut-in areas and portable fire extinguishers.

(c) Yellow - Oxygen/OBIGGS bottles/systems and converters and window cut-in areas.

(d) Black - Batteries.

(e) Purple - Hydrazine.

(f) Orange - N2O4 Nitrogen Tetroxide.

(g) Green - Ammonia.

(h) Brown - Hydraulic and oil fluid systems.

(i) Miscellaneous Colors - Airframe structure, composite materials, chemicals, and radioactive materials. A key will be provided to determine these items corresponding to an accompanying graphic. Other support information may be provided to inform the user of these unstable substances in a mishap response incident.

d. Normal/Manual/Emergency Entry:

(1) Normal/Manual - location and operational details for doors, hatches, and handles for manual aircraft entry.

(2) Emergency - location and operational details for doors, hatches, handles and canopy/hatch jettison controls.

(3) Skin Penetration and Cut-In - location and identifying markings of areas.

e. Engine/Auxiliary Power Unit (APU)/Emergency Power Unit (EPU) and Battery Shutdown:

(1) Engine - location and position of engine throttle/control levers, engine fire shutdown switches, and T-handles for fire retardant agent release.

(2) APU/EPU - Location (internal and external) and position of APU/EPU master control switches, and fire retardant agent release switches.

(3) Battery - Location and operational switches for shutdown from flight deck or manual disconnect at battery terminals.

f. Ejection/Escape System Details:

(1) Location of ejection seat/s, canopy/ies, hatch/es and door/s jettison systems and associated control handles.

(2) Location and method for safetying and/or cutting initiator hoses, shield mild detonating cord (SMDC), or flexible linear shaped charge (FLSC) to disarm the system.

(3) Identification and location of initiating (triggering) devices (e.g. face curtain, D-ring, armrest/ejection control handle) and dangerous mechanical linkages that can initiate the system if pulled, hit or damaged.

(4) Location of initiators, rocket catapults/packs/motors, drogue guns for forced parachute deployment, canopy/hatch removers, and any other possible danger areas related to the system.

g. Aircrew/Passenger Extraction:

(1) Location of handles/controls, quick-disconnects, releases for safety belts, harnesses, straps, restraints, hoses and any other personnel connections that prevents entanglement during the extraction process.

(2) Location and release of survival kits and personal parachutes.

(3) Location of seat positioning controls (tilt, vertical, horizontal, pivotal), associated switches and their operation.

h. Information Presentation: To facilitate maximum presentation of information in Chapter 4 and onward for each type and model aircraft, all general arrangement contents will list special tools/equipment on top left corner of page, including aircraft type on right side with a view of the color code identifying location of fuel, armament, control switches, oxygen, cut-in and skin penetration areas, and batteries. Respectively, the four basic steps in detail will be listed on left side of the page: step by step method of aircraft entry, engine/APU/battery shutdown, ejection system safety, aircrew extraction. Other pages maybe added to expand the methodology of the four basic areas including modifications and hazards affecting the rescue of personnel.

1-2. HOW TO OBTAIN COPIES.

a. Military Organizations: Download this TO from the designated web site at Robins AFB, GA to a PC hard drive or writeable CD-ROM. The official web address is **http://137.244.215.33/ti/tilta/documents/to00-105E-9.htm.** The official web address for this TO's Safety Supplements is **http://www.afcesa.af.mil/Directorate/CEX/fire/default.htm#Publications**. This manual uses the Adobe Reader software for downloading and reading the portable document format (PDF) files. This manual will be maintained in each user customer's master TO file. The downloaded PDF file have print capability for user copies for the fire chief's vehicle, alarm communication center, training section and mishap responder teams. A color printer is recommended to take advantage of the color coding. This publication will be maintained in current status by the using organization. The National Guard and Reserve units may obtain this publication by following the above procedures. Any installation desiring information on Navy aircraft may requisition NAVAIR 00-80R-14, 00-80R-14-1, and 00-80R-20 in accordance TO 00-5-2. NAVAIR now has an assigned web site for their publications at **http://www.natec.navy.mil**. US Navy/Marine aircraft information has been incorporated in Chapters 18 -23. Other agencies, i.e., Army, Navy, FAA, may obtain copies of this manual as stated above.

b. Non-availability of Paper Copies. Paper copies are no longer distributed by the technical content manager. CD-ROM distribution is only considered under special circumstances, such as a customer not having internet access at his installation.

c. Non-Military Organizations: The web site is a public web site and the information can be downloaded without restrictions. Foreign government access has also been authorized.

d. Customer Accounts. Customer accounts do not have be established and the techncial content manager does not have be contacted for authorization to use the manual.

e. Printing Copies. Printing the whole TO is not necessary for operations use and very expensive. For this reason it is recommended by HQ AFCESA/CEXF that users only print those desired pages affecting assigned, transient, special occassion, static display, etc. aircraft only. This partial printing of information is for those units desiring to store printed information in rescue and other emergency response vehicles in book form. The rationale behind this recommendation is that no one unit will have assigned every weapons system at its location, however it must be sensitive to those aircraft that frequent their location on the ground and fly in their vicinity.

1-3. RECOMMENDING CHANGES.

a. MAJCOM Fire Protection and Emergency Response Functions: These functions are responsible for notifying HQ AFCESA/CEXF of any desired/required changes to this TO for their assigned aircraft. AFTO Form 22s will be used for recommending changes or correcting errors IAW AFR 60-9 and TO 00-5-1. The forms will be forwarded through the MAJCOM to HQ AFCESA/CEXF which is designated as the Office of Primary Responsibility (OPR) and functional manager for the technical content and management of this TO. Go to the contact page for further information if contacting the technical content manager is required. (Page two of each Segment.)

1-4. AIRCRAFT PRE-FIRE PLAN.

a. AFTO Form 88 or Computer Generated Equivalent: will be used to supplement lesson plans for aircraft familiarization and egress training. The prepared or computer generated form for an aircraft will be inserted, preceding the first page, into the appropriate aircraft section of this Technical Order.

b. Optional Computer Generated AFTO Form 88: An optional computer generated form, allows for greater flexibility for information, over the 20 year old printed form.

c. AFTO Form 88 Use: Information may be expanded to include areas as follows: the Incident Command System/assignments, manpower utilization, agent requirements and availability, vehicle position at the aircraft, duties of the rescue crew, fire suppression team and other optional information peculiar to local operations. Extended hazard and safety information, not included in Chapter 3 of this Technical Order, may be included, but HQ AFCESA/CEXF should be informed to see if these areas have wider applicability.

c. AFTO Form 88 Misuse: This form is not to be used to change official/approved procedures stated in the TO. This violation may cause far reaching implications leading to a failed rescue and loss of an aircraft. AFTO Form 88 information should never contradict procedural information that has been fully researched through multiple channels such as the aircraft manufacturer's engineers, the aircraft SPO, and approved source data submitted by these channels to assemble the aircraft file specifically used for successful emergency responses, aircrew and passenger extraction, and saving the aircraft/resourse. Authorities responsible for writing the AFTO Form 88's information should ensure these precautions are taken before operational implementation.

CHAPTER 2
GENERAL AEROSPACE RESCUE AND MISHAP INFORMATION

2-1. PURPOSE AND SCOPE.

2-2. The introduction of high performance aircraft and aerospace vehicles into military and commercial use has resulted in aircraft/aerospace design changes that affect the rescue of personnel and mishap response under emergency and post-emergency conditions. The continuing search to improve personnel escape and survival has resulted in many changes and modifications to equipment. Fire protection and mishap response personnel must keep abreast of these changes and modifications as they occur, so they may safely and quickly perform their duty of rescuing personnel under emergency conditions and post incident environments. Lack of knowledge may result in fatal or serious injury to the fire protection and mishap response personnel as well as to those they are attempting to rescue. Of necessity this chapter is general in nature and does not include equipment, procedures or modification for each type aircraft. Familiarization with the type aircraft fire protection and mishap response personnel may encounter, must be scheduled by the fire chief and/or an incident commander. This should be accomplished in coordination with local Egress technicians, Life Support technicians, aircrew and response team members.

ORGANIZATION, PROCEDURES, TACTICS, FIREFIGHTING EQUIPMENT, AND TRAINING ARE DEVOTED TO ONE CAUSE: THE RESCUE OF PERSONNEL INVOLVED IN AIRCRAFT EMERGENCIES.

THE SECOND CAUSE IS TO SAVE THE AIRCRAFT OR AEROSPACE VEHICLE FROM FURTHER DAMAGE WHILE KEEPING THEMSELVES SAFE INSIDE THE INCIDENT OR MISHAP AREA.

2-3. RESCUE AND MISHAP PERSONNEL RESPONSIBILITIES.

2-4. Rescue and mishap response personnel will be proficient in:

a. Aircraft entry, normal and emergency methods including crew, passenger locations for type aircraft involved. If conditions permit, enter the aircraft through normal access provisions, i.e., doors, canopies, and hatches, as this provides the most effective and expeditious entrance into the aircraft. At times, entry through a confined space may be necessary. Paragraph 2.59 defines confined space for USAF aircraft according to AFOSH Standard 91-25.

b. Engine(s) and APU/EPU shutdown, emergency engine and APU/EPU shutdown procedures. Personnel will be knowledgeable of other engine and APU/EPU shutdown procedures, i.e., normal. If aircraft type alllows, engine(s) and APU/EPU shutdown will be accomplished immediately after gaining access to the cockpit or flightdeck. If the aircraft intake location presents a hazard, use an alternate engine(s) and APU/EPU shutdown procedures if applicable, to preclude the danger and possibility of personnel ingestion, and/or engine disintegration/exhaust burns/turbulence.

NOTE

Emergency seat or escape system safetying procedures may be accomplished prior to engine shutdown on those aircraft equipped with ACES II ejection seat(s); if, in the professional opinion of the rescue crew, engine shutdown will not be delayed.

c. Ejection system safetying procedures and precautions for the type seats used on various aircraft.

d. Aircrew extraction and methods of releasing crewmembers from seat restraints and survival equipment. Personnel shall also be knowledgeable of safety precautions required during the removal of aircrew member's life support equipment and high pressure flight suits.

2-5. ENTRY AND EXIT FACILITIES.

2-6. DOORS.

2-7. Depending upon type of aircraft, doors may be located on either side of the fuselage, or in the rear of the fuselage. Doors may open to the side, up or down, and from the interior or exterior of the aircraft. In many cases an emergency release is provided in the interior at the hinge side of the door. The release location is normally indicated and the pull handle is painted red. Pulling the handle will withdraw the pins from the hinges. This arrangement, if the latch or frame is jammed, will allow the door assembly to be pushed out of position from the hinged side.

WARNING

Some aircraft doors, when opened from the inside the aircraft, escape slide or chutes manufactured with flammable materials, are deployed. These escape slides or chutes, if deployed during the rescue process, may endanger the rescue crew who are attempting to enter the aircraft. The intended use these doors should be known.

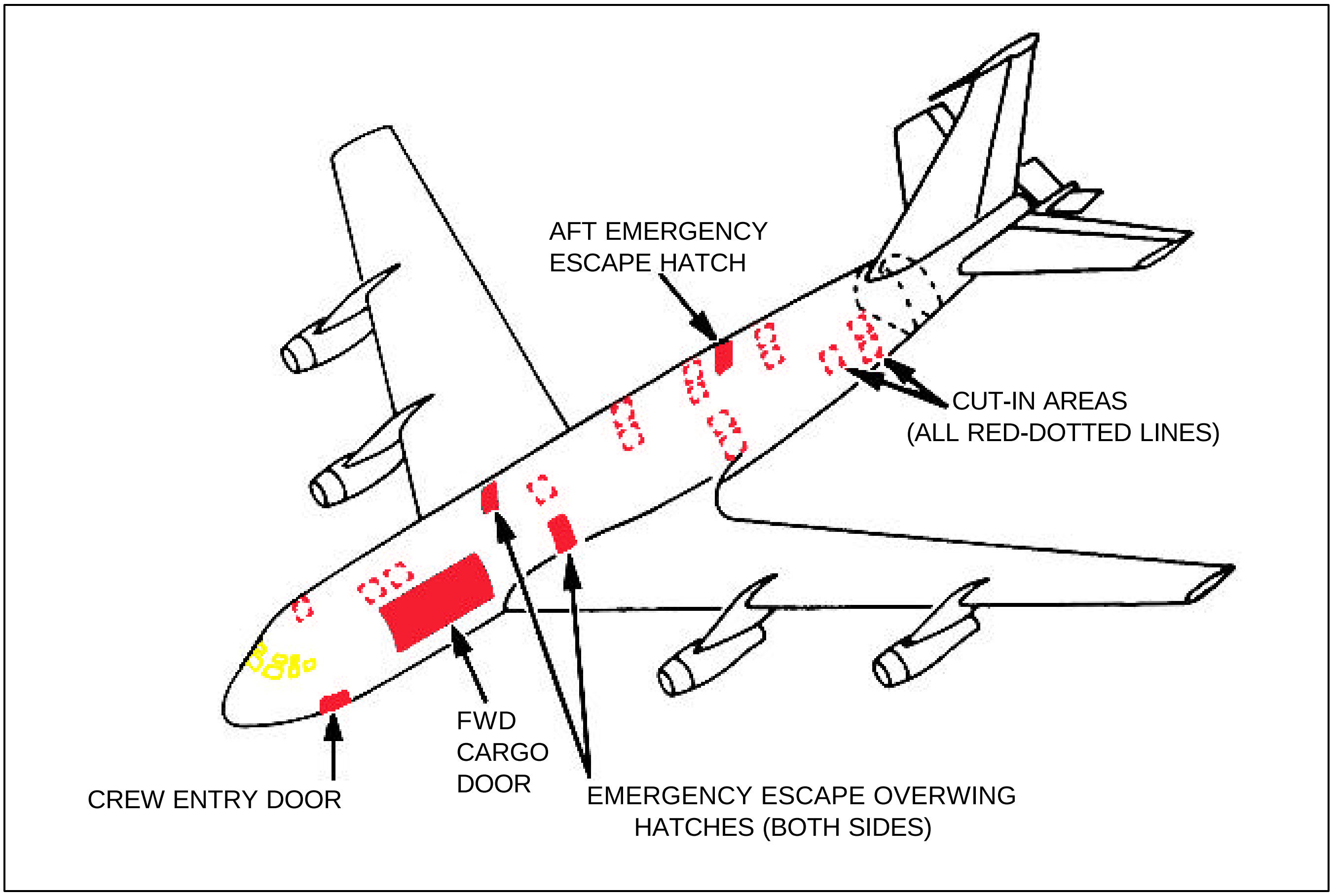


Figure 2-1. Hatch Location for One Type of Aircraft

2-8. HATCHES

2-9. Hatch locations vary according to type of aircraft and may be located on the sides, bottom or top of the fuselage. Hatches designed for normal personnel access are hinged and may be opened internally or externally. Hatches designed for emergency escape from the interior of the aircraft are generally secured internally with quick-opening compression devices around the circumference and when released from the inside or outside of the aircraft the complete hatch is removed. Figure 2-1 shows different locations of hatches on one type aircraft. The study of hatch locations and the means of opening for specific aircraft are included in Chapter 4 throughout the remainder of the publication.

2-10. CANOPIES.

2-11. The canopy, a metal framework with a transparent material covering, is provided to enclose the cockpit and afford protection and visibility to the pilot and/or crewmen. The canopy system includes the canopy itself, plus all the components used in opening and closing for normal entrance and exit, as well as those used in jettisoning the canopy during an emergency. Three types of canopies, the clamshell, sliding, and hinged are commonly used on military aircraft (see Figure 2-2). The clamshell is hinged aft and opens upward at the forward end. The sliding type rests on tracks on the fuselage and opens and closes by a sliding action. The hinged type is hinged at the side or top and opens from the side. The sliding type canopy offers the greatest ease in rescue of crewmember(s) since no overhead restrictions exist. Special emphasis must be placed on drills for removal of crewmember(s) from aircraft utilizing clamshell canopies to assure that fire protection personnel are thoroughly familiar with restrictions imposed.

2-12. CANOPY OPENING.

2-13. The method employed to open a canopy varies with the type of aircraft. They may employ one, two, or three methods of opening. Fire Protection personnel must become familiar with each method in order to gain access in the most expedient manner. Normal opening procedures are the primary means of gaining access to the cockpit, followed by manual jettison and finally cut-in method. If conditions warrant, canopy will be jettisoned.

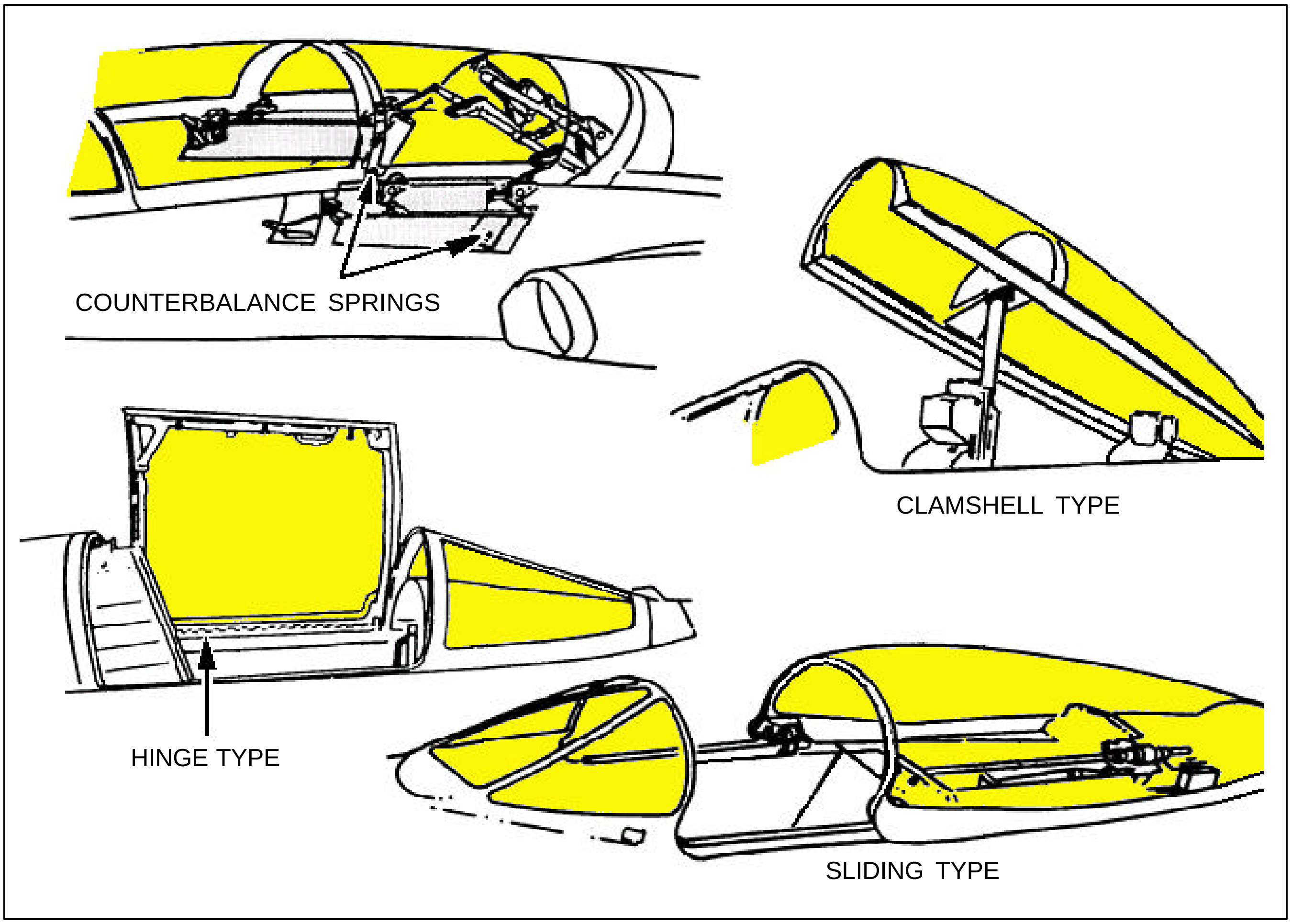


Figure 2-2. Types of Canopies

2-14. NORMAL. Normal opening and closing may be accomplished either pneumatically, electrically, hydraulically and mechanically with counterbalance springs. In the event of malfunction or mechanical damage to the canopy system, it may be opened manually. When the clamshell and pneumatic canopy is opened manually, it must be physically held, propped, or locked open with a canopy lock depending on type of aircraft.

2-15. JETTISON. Jettisoning is another method of opening the canopy. A handle for this purpose is located on the exterior of the aircraft, either left or right under the canopy sill and so identified. The handle is normally concealed behind a hinged access door and is normally red or yellow and black in color. The trajectory of the canopy is normally up and aft under conditions with no wind. Personnel selecting canopy jettison need to stand forward of this trajectory while making sure that the impact area is vacated by all personnel. During adverse conditions, the canopy can impact the aircraft, causing possible damage to fuel cells thus increasing the fire hazard as fuel is exposed to fire. Under these conditions, all considerations for canopy jettison can not be overlooked.

WARNING

The ejection seat is armed at all times during flight and should be considered armed until safetied. Be sure to clear impact area when jettisoning canopies - DEATH or INJURY can occur from falling jettisoned devices. Keep in mind when jettisoning a canopy, the jettisoned canopy may impact and damage other aircraft that are parked in the vicinity. Never jettison a canopy in a covered area such as a hanger, radar or inspection dock.

2-16. PREVENTION OF SUFFOCATION.

2-17. To eliminate the possibility of crew member suffocation from lack of oxygen due to a damaged system or other obstruction to the air passage, fire protection personnel must act expeditiously during aircraft ground emergency conditions. As soon as crew members are reached, immediately disconnect their oxygen face masks and hoses. IF A PRESSURE SUIT IS BEING WORN, DEPRESSURIZE THE SUIT BEFORE OPENING THE FACEPLATE. These procedures will be followed except when an oxygen mask or faceplate would provide additional fire, fumes, or heat exposure to the crew member. Refer to Figure 2-3 for depressurization of pressure suits and faceplates; Figure 2-4 for disconnecting oxygen masks; and Figure 2-5 for disconnecting oxygen hoses.

2-18. REMOVAL OF PERSONNEL FROM SEAT.

2-19. In order to accomplish rescue of personnel involved in an aircraft incident, they must be removed from their seats. Seat restraints may range from a simple lap belt in transport aircraft, to shoulder harness, lap belt systems and leg and arm restraints. More sophisticated systems are employed in high performance aircraft.

2-20. SEAT RESTRAINT EQUIPMENT.

2-21. To restrain personnel in their seats, four systems are employed as follows:

a. Lap belt.

b. Lap belt and shoulder harness combination.

c. Integrated torso harness, including a crotch strap.

d. Leg and arm restraints.

2-22. The lap belt is a belt provided across the lap, which when secured, restrains personnel in the seat. The safety belt in an automobile operates on the same principle.

2-23. The lap belt and shoulder harness combination provides a lap belt and two shoulder harness straps,one over each shoulder. The shoulder harness straps fit into the lap securing fitting. Addition of the shoulder harness straps prevents the upper part of the body from being thrown forward in event of a crash. To release lap belt and shoulder harness straps from the locked position after a G force lock, pull harness release handle or inertia reel release handle upward. The lap belt and shoulder harness straps tension will be released. A lapbelt fitting and shoulder straps fittings are provided for quick manual release from the crew member.

2-24. The standard military parachute harness can be removed by releasing three ejector release fittings. One fitting snaps across the chest of the wearer, and one snaps across each leg at the thigh. When leg and chest straps are unhooked, the harness and all attached gear can be slipped off the shoulder of the wearer. See Figure 2-7.

2-25. TORSO HARNESS SUIT AND TORSO HARNESS.

2-26. The integrated torso harness suit and torso harness, see Figure 2-8 and 2-9, are designed for use in military aircraft with integrated parachute/restraint harness systems. In comparison with the standard restraint (lap belt and shoulder harness) and the parachute harness system, the integrated system improves comfort, mobility, and retention; provides better donning and doffing features; and reduces the number of fittings used to release the parachute and accomplish seat separation. See Figure 2-8.

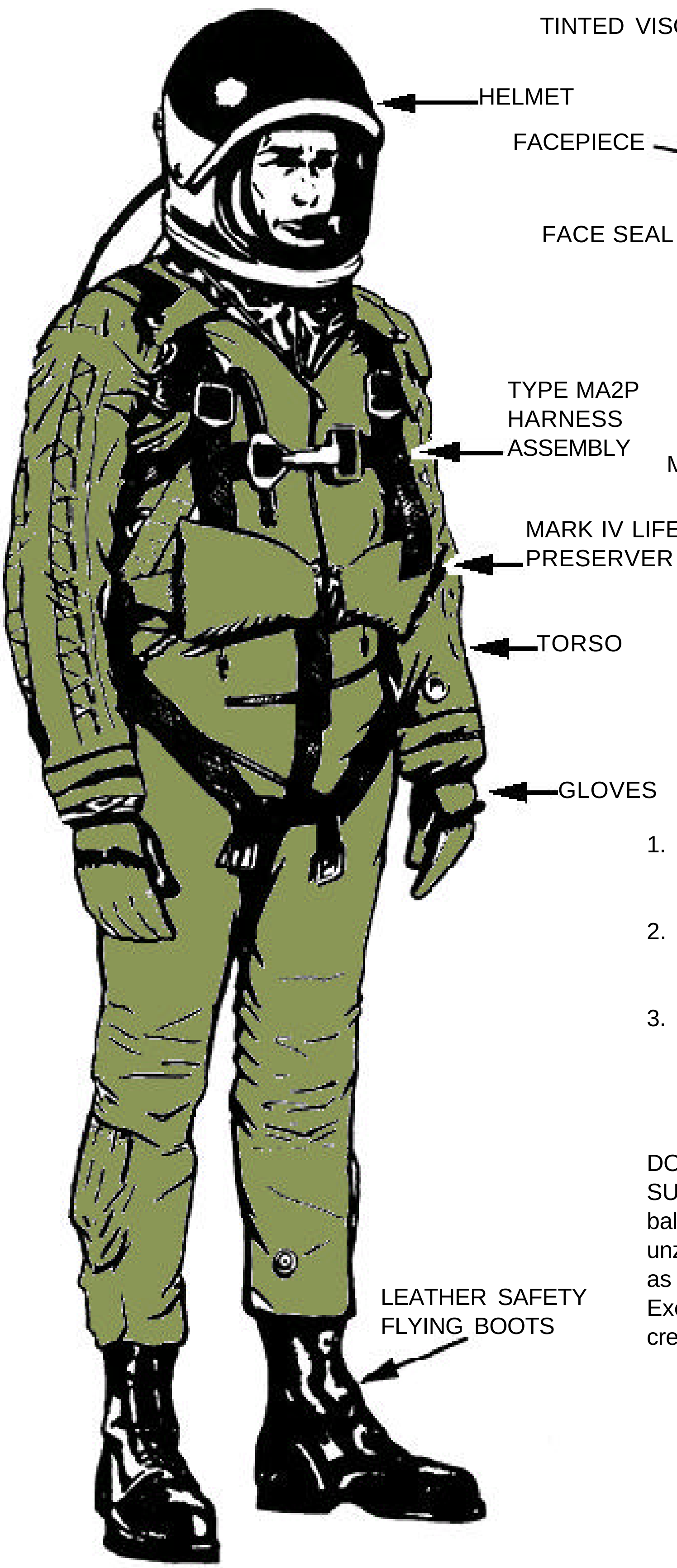
2-27. Three different type release fittings are used on the integrated system; these are the Rocket Jet, Koch, and Frost fitting. Figure 2-9 shows the releasing procedure for Rocket Jet and Koch. Frost fitting is shown in the F-16 Fighter Chapter 8.

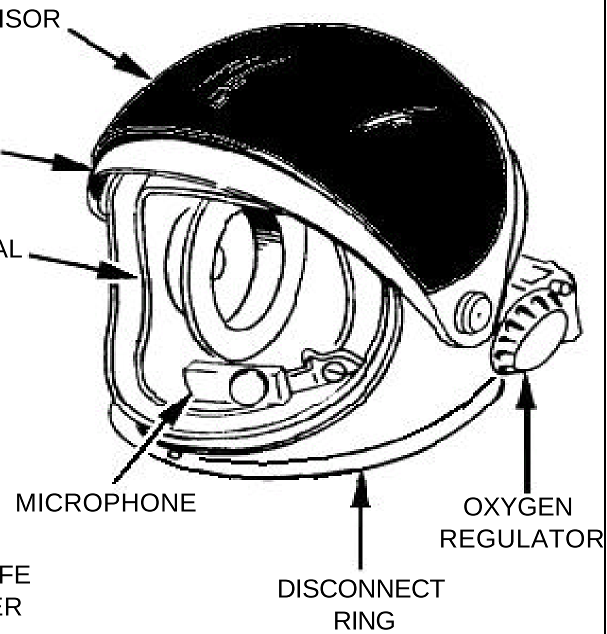
2-28. PERSONAL SERVICES CONNECTIONS.

2-29. According to manufacturer of the aircraft, the personal services connections in aircraft will vary in type, method of disconnect, and locations of connections. In aircraft familiarization training, these conditions must be included, as they must be disconnected prior to removing personnel from their seats. These connections include the oxygen supply hose, anti-G pressurization, vent air, and on full pressure suits, an exhaust vent hose and communication leads.

2-30. LEG AND ARM RETENTION DEVICES.

2-31. On some types of ejection seats, leg and arm retention devices are incorporated. See Figure 2-10 for leg type.These devices will prevent removal of personnel in rescue operations unless the retention devices are released, as those devices are attached to the seat .The leg restraint devices may be released by manually actuating the leg restraint release lever, by manually releasing the fittings on the straps. Arm restraints employ a web that spreads over the arms with a wand spring, lanyards are attached to floor.





1. To raise tinted sun visor, depress button on right side hinge point.

2. Slide oxygen switch (regulator) aft to off. Face seal will deflate when oxygen is shut off.

3. Push facepiece up.

WARNING

DO NOT OPEN FACEPIECE WHEN SUIT IS PRESSURIZED. Pressurization will be identified by the ballooning appearance of the suit. Vent pressure by unzipping and removal of a glove, opening zippers or as a last resort by cutting an opening into the suit. Exercise caution when cutting to prevent injury to crewman.

Figure 2-3. Full Pressure Suit and Helmet

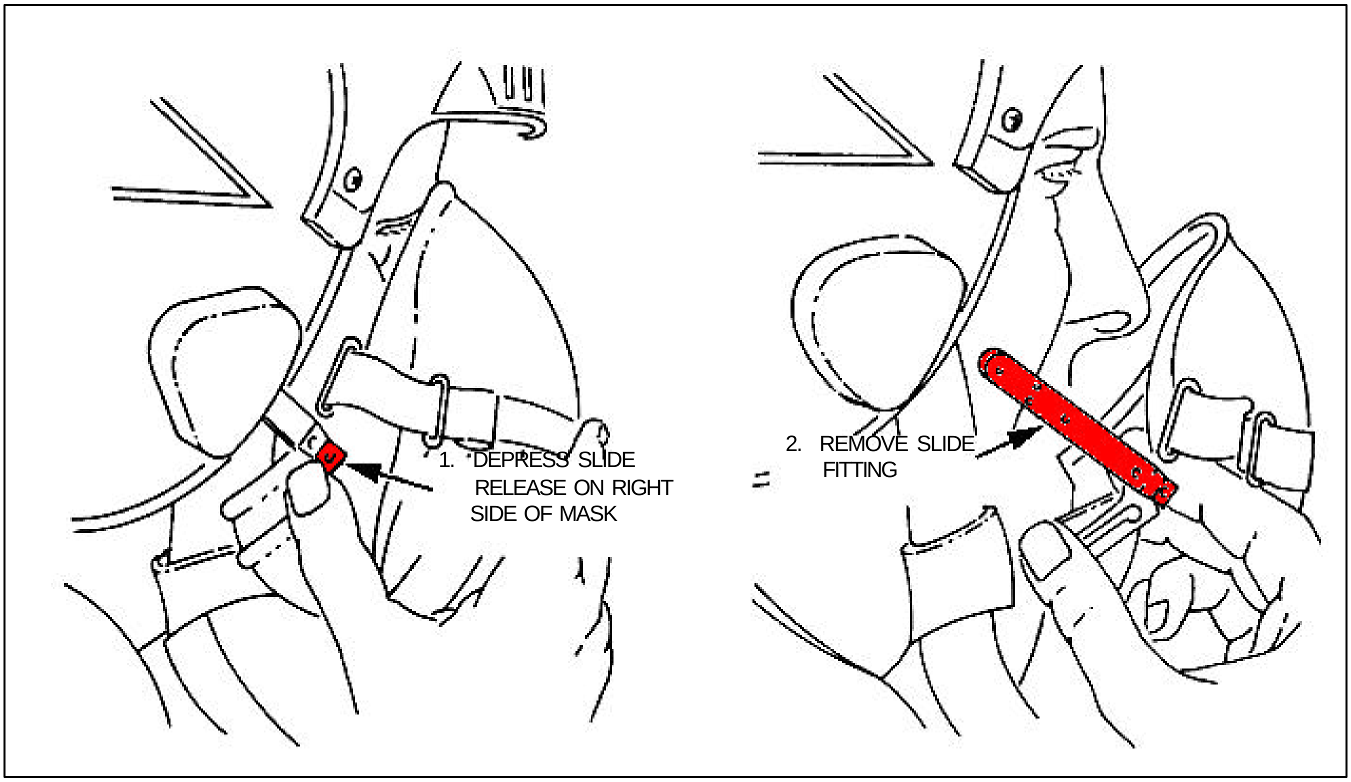


Figure 2-4. Removal of Oxygen Face Mask With Sierra Slide Fittings

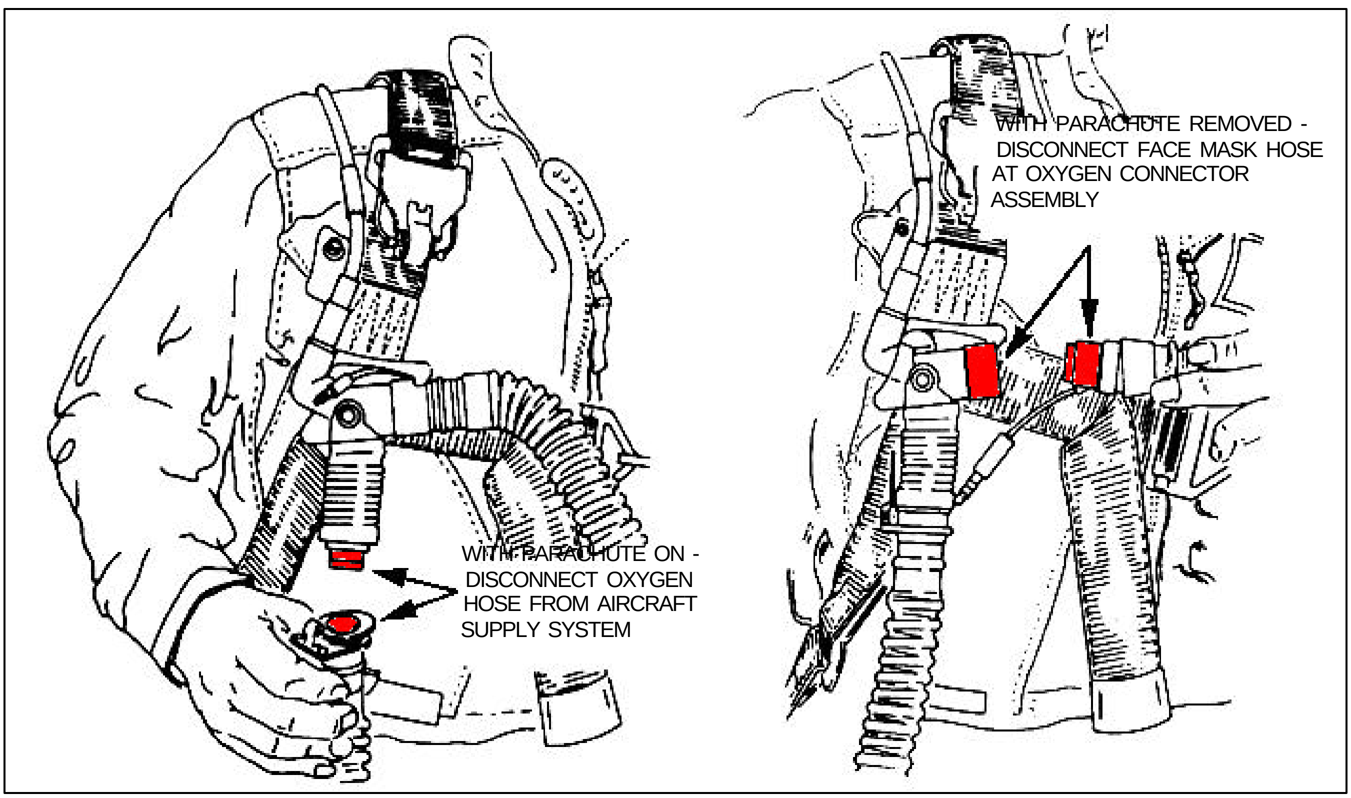


Figure 2-5. Disconnecting Oxygen Hoses With Crewmember Wearing Parachute and Parachute Removed

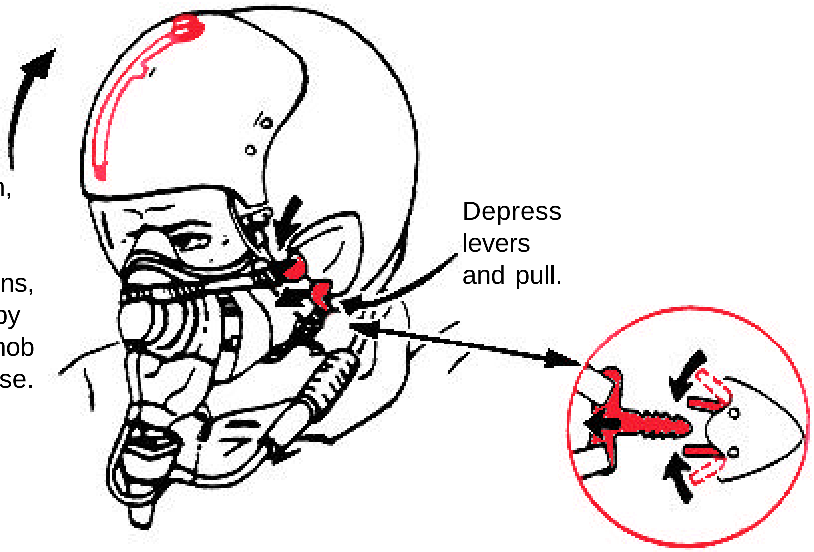


Figure 2-6. Removal of Oxygen Face Mask With Hardman Fittings

2-32. EMERGENCY HARNESS RELEASE.

2-33. On aircraft utilizing certain types of ejection seats, an emergency harness release system is incorporated on the seat to release the crewmember from his seat. Aircraft employing the ACES II seat have changed the function of this handle and it no longer releases the restraint system. Restraints will have to be manually separated in this case. By pulling this handle, most devices employed to restrain the crewmember in the seat are released. In some cases, the parachute and survival kit are still attached to the crewmember and must be manually separated as well. The parachute and survival kit weight is between thirty and sixty five pounds, which adds to the difficulty of personnel rescue. Some seats employ an explosive cartridge in the emergency release system. When the handle is actuated, the cartridge is expended and forcibly releases and cuts through the restraints and parachute chords to release the crewmember saving precious time during the rescue.

Release procedures for the parachute and survival kit:

a. Pull up on emergency release handle to release survival kit.

b. Release parachute harness fittings. See Figure 2-9.

c. Disconnect vent air hose and anti-G suit hose from left console by pulling hoses sharply apart.

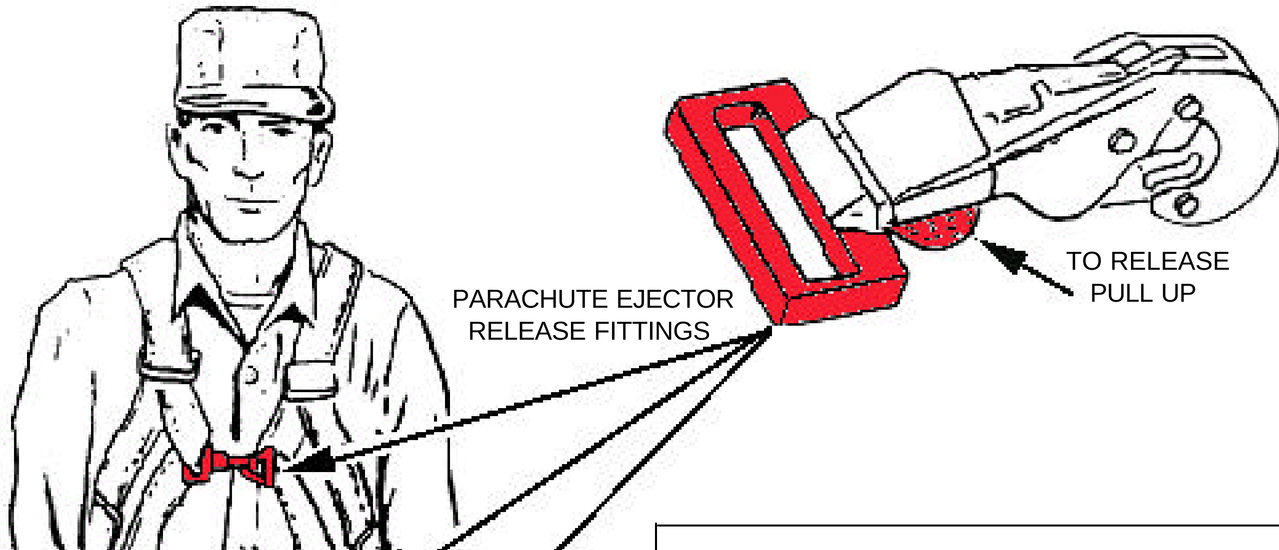
WARNING

Fire protection personnel must be thoroughly familiar with aircraft incorporating the emergency harness release system. Some Air Force aircraft utilize a handle similar in appearance to the emergency harness release handle on the seat armrest, which will fire the canopy and eject the seat. Death or severe injury will occur in this case.

2-34. EJECTION SEATS.

2-35. EJECTION SEAT FIRING MECHANISMS.

2-36. Of primary concern to fire protection personnel is the prevention of inadvertent firing of an ejection seat or canopy or hatch during rescue operations. Firing of the escape system devices, especially the ejection seat, during rescue operations would in all probability be fatal for the crewmember and very likely for fire protection personnel as well. As previously stated, ejection seats vary in design, operation and firing procedures, and as research continues, additional seats or modifications to present seats require keeping abreast of all changes that affect rescue of personnel. This is accomplished by aircraft familiarization classes and the reviewing of aircraft Maintenance Instruction Technical Orders for all current inventory aircraft.



TO REMOVE PARACHUTE

1. Unfasten the leg straps by releasing the ejector fittings.

2. Release the chest strap by releasing the ejector fitting.

3. Slip shoulder straps over the shoulders.

Figure 2-7. Standard Military Parchute Harness

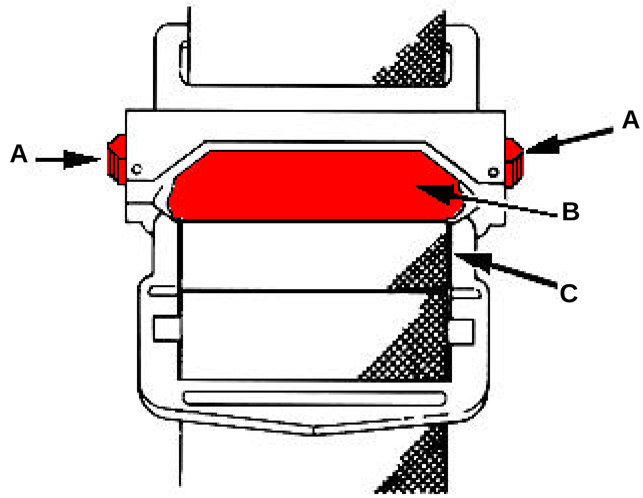
A. Releases crewmember from the seat and survival equipment.

B. Releases crewmember from the parachute.

C. Personal services connection.

NOTE:
If incorporated in the seat, leg restraint lines and/or arm restraint cables will require disconnecting.

Figure 2-8. Integrated Torso Harness Suite

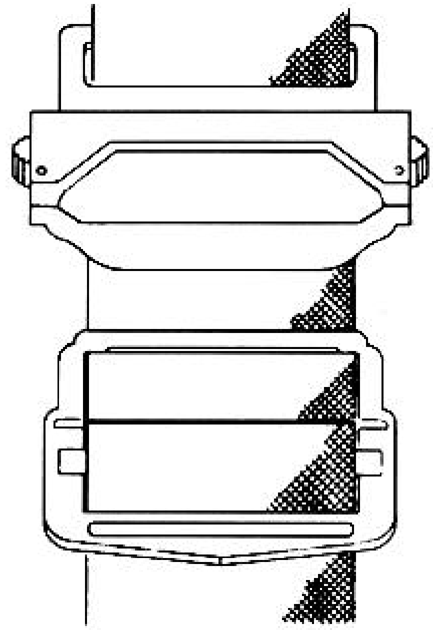


FITTING CONNECTED

1. To release Rocket Jet Fitting, squeeze knurled buttons marked “A”.

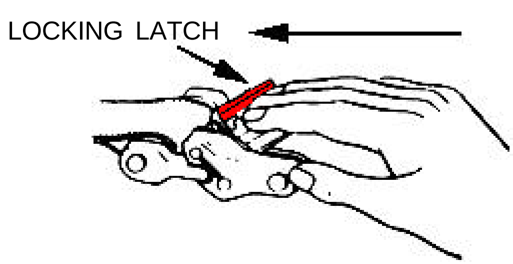
2. Slide locking collar marked “B” up.

3. Lift ring marked “C” out of slot.

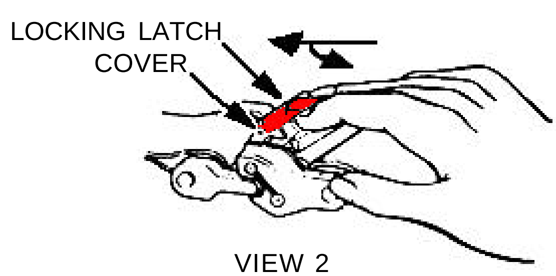


FITTING DISCONNECTED

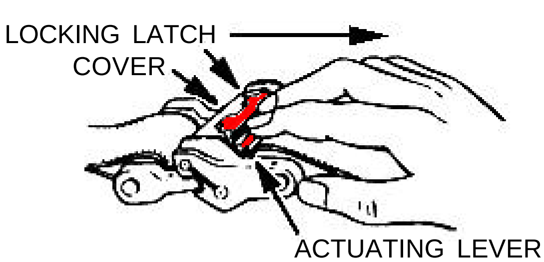
ROCKET JET RELEASE FITTINGS



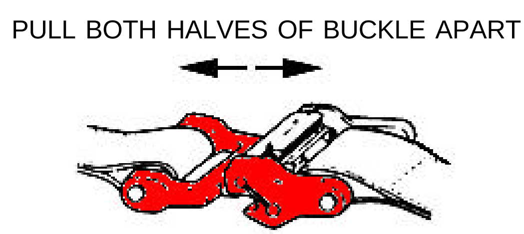
VIEW 1



VIEW 2



VIEW 3



VIEW 4

KOCH PARACHUTE RISER SHOULDER HARNESS BUCKLE

Figure 2-9. Release of Rocket Jet and Koch Harness Release Fittings

2-37. Fire protection personnel are concerned with the various ways an ejection seat and/or drogue gun, if incorporated, may be inadvertently fired. We know the results if an ejection seat is fired, but if the drogue gun is fired with personnel in its trajectory, the results could be fatal.

2-38. Many ejection seats are fired from the aircraft by pulling down a face curtain handle. The lower firing handle, or "D" ring, is normally located on the forward portion of the seat between the legs of the occupant; however, the lower firing handle may be located else where on the seat. On most Air Force aircraft, the seat firing mechanism is located on the forward portion of the armrest. A rule of thumb to be observed is, "If the seat does not have a face curtain, beware of the armrests." In attempting to get into the cockpit to effect rescue, it is a natural tendency to reach for a handhold The face curtain is ideally located as a handhold, which if used as such, most likely will cause the seat to fire. Unless the necessary safety precautions are exercised prior to removing the crewmember, his flight clothing or feet can become entangled in the lower firing handle or armrest firing mechanism and cause the seat to fire, see Figure 2-12.

2-39. DROGUE GUN.

2-40. Certain drogue parachutes are deployed by means of a drogue gun. The drogue gun on the Martin -Baker seat is normally located on the upper portion of the left side of the seat frame-work. The gun consistsof a barrel, which requires the drogue gun cartridge, and a weighted piston. When the seat is ejected or the drogue gun mechanism is inadvertently tripped, a sear is withdrawn from the firing mechanism of the gun. This causes the piston to be fired from the barrel, thereby extracting the drogue parachute from its container. See Figure 2-13 for a view of drogue gun used on one type of seat. The drogue gun may be fired by an accidental tripping of the trip rod or gun actuator. When safetying the drogue gun, it is adviseable not to place yourself over the barrel and in the trajectory area of the weighted piston.

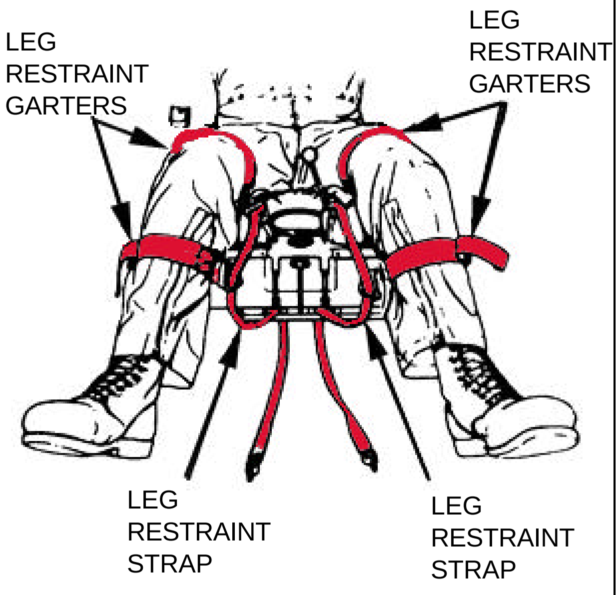


Figure 2-10. Leg Retention Devices

If the seat incorporates the emergency harness release system, the method of operation and location will vary, depending upon the ejection seat manufacturer.

Figure 2-11. Emergency Harness Release

2-41. SAFETYING THE EJECTION SEAT.

2-42. The method of safetying the ejection seat varies with the manufacturer's different models and modification to the seat. The firing mechanism which causes the seat to eject is mechanically or gas activated. All seats have ground safety features which will render the seat safe for removal of personnel. See Figure 2-14. Safetying of ejection seats is a simple task for those familiar with the safetying features. Of prime concern to the fire protection personnel is:

SAFETYING CATAPULT FIRING MECHANISM
SAFETYING OF EJECTION HANDGRIPS

Safetying of the seat or seats may be accomplished by:

a. Insertion of safety pins in the catapult firing mechanism and the drogue gun.

b. Insertion of safety pins in the ejection seat firing handles, triggers, or face curtain.

c. By rotating the seat ejection ground control safety lever up and forward, if incorporated OR by rotating a "red flag" up to safe the lower ejection control "D" ring.

d. Mechanically actuated firing mechanisms may be disarmed by (1) insertion of safety pins in the catapult firing initiator, (2) disconnecting the gas line between the firing initiator and a catapult by means of the quick disconnects or (3) cut the initiator hose between the firing mechanism and the catapult.

2-43. If time does not permit normal safetying of the seat, cut the initiator hose. Figures 2-15 and 2-16 showmethods by which some ejection seat catapult firing mechanism are safetied.

2-44. FORCIBLE ENTRY.

2-45. TRANSPARENT PLASTIC COVERED AREAS.

2-46. In gaining entry into the canopy by forcible means, the desire is to obtain the largest opening in the shortest period of time. Using a power rescue saw, this is accomplished by cutting the plastic along the edges of the frame. In cutting, commence operations at the front of the frame. After three sides have been cut, carefully cut the fourth side and prevent the glass from falling on the crewmember during removal. Older aircraft canopies can be cut on three sides, lifted, and broken off. See Figures 2-16, 2-17, and 2-18.

WARNING

Extreme caution must be exercised when cutting the top rear of the canopy, to avoid hitting crewmember(s) and firing the ejection seat firing mechanisms in this area.

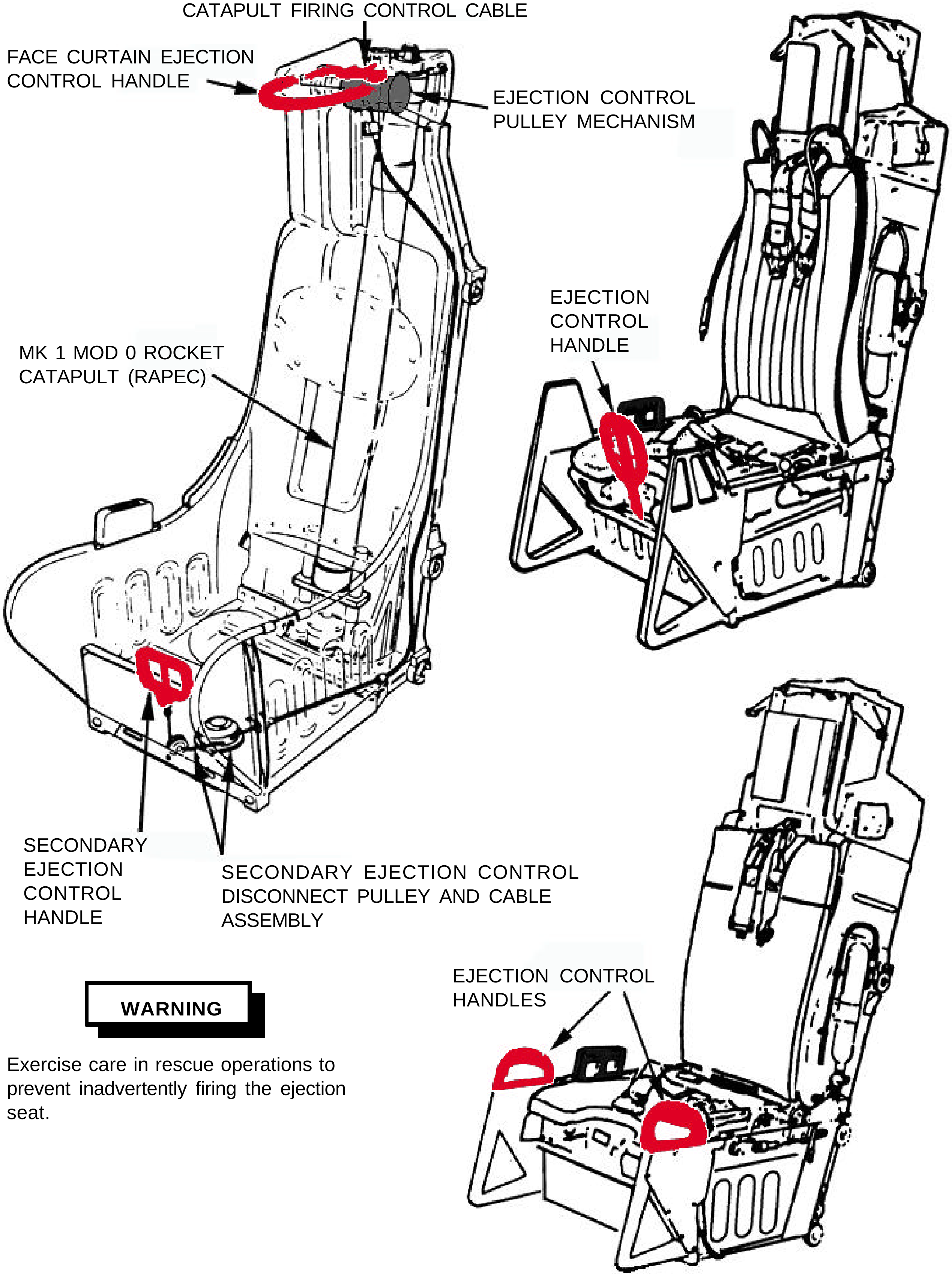
NOTE

For new generation transparencies use a thick Carbide tipped blade in the power rescue saw.

2-47. FORCIBLE ENTRY INTO FUSELAGE AREAS.

2-48. Gaining entry into aircraft through the fuselage presents the most difficult problem in making forcible entry. The increase in performance of aircraft has placed a demand on increasing the thickness and strength of the aircraft skin. Fire protection personnel, when cutting through the fuselage, must have a knowledge of the aircraft interior. He/she must know the locations of bulkheads, equipment inside the aircraft that would prevent entry, location of fuel tanks, fuel, flammable liquids, oxygen lines and cylinders, and where forcible entry presents the least obstacles to cut and gain entry. On large aircraft, an outline of cutting areas is stenciled on the aircraft exterior, as an aid to fire protection in making forcible entry. These marked areas offer the least obstacle in gaining entry. Markings are red dashed lines in a rectangular or square shape.

2-49. Fire Protection personnel must not be dependent upon these markings, as they may be obliterated during an incident. However, during aircraft familiarization, fire protection personnel must study these areas and become familiar with their location on all types of aircraft. When making forcible entry, the desire is to gain the largest opening as quickly as possible. The power rescue saw, equipped with metal cutting blades, is the most satisfactory tool for forcible entry. If the aircraft is relatively thin skinned, three cuts may bemade and then the area cut may be bent down and outward from the aircraft. If the aircraft fuselage is of thicker material, four sides must be cut. When cutting through an aircraft, particularly when utilizing the power rescue saw, a danger exists of ignition of fuel, or any other flammable liquid, that may be present by sparks produced by the cutting operations. Adequate fire prevention measures must be taken and standby protection should always be at hand.



WARNING

Exercise care in rescue operations to prevent inadvertently firing the ejection seat.

Figure 2-12. Examples of Ejection Seat Firing Mechansim

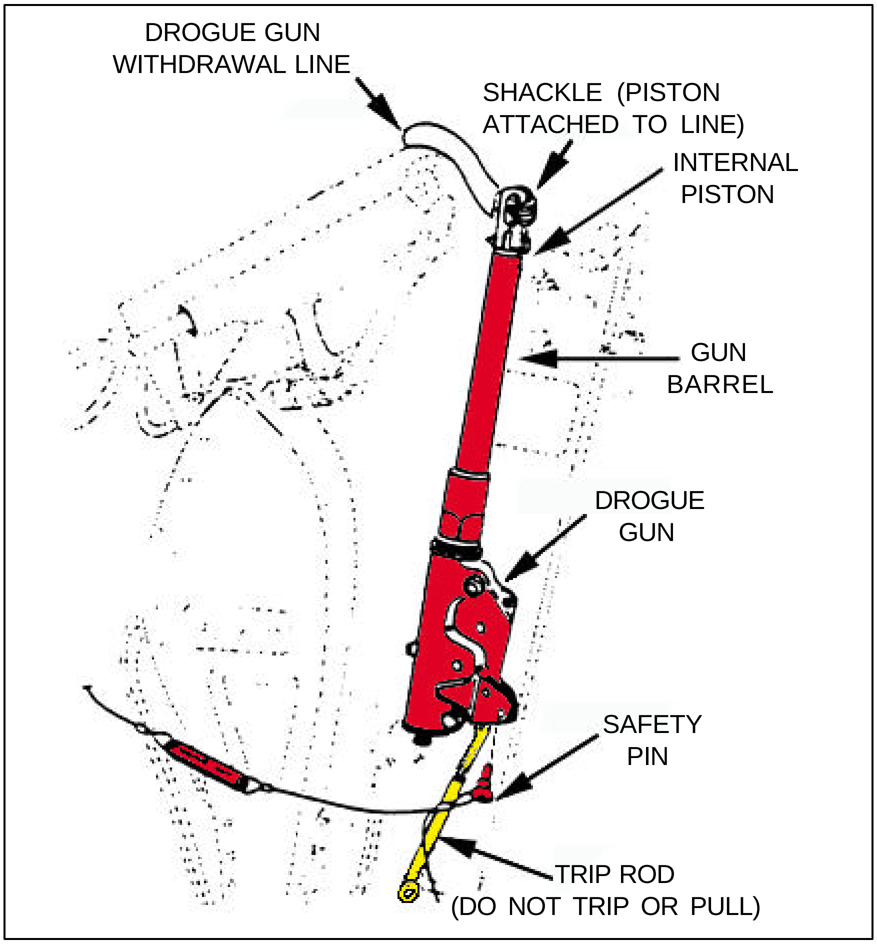


Figure 2-13. Martin-Baker Ejection Seat Drogue Gun

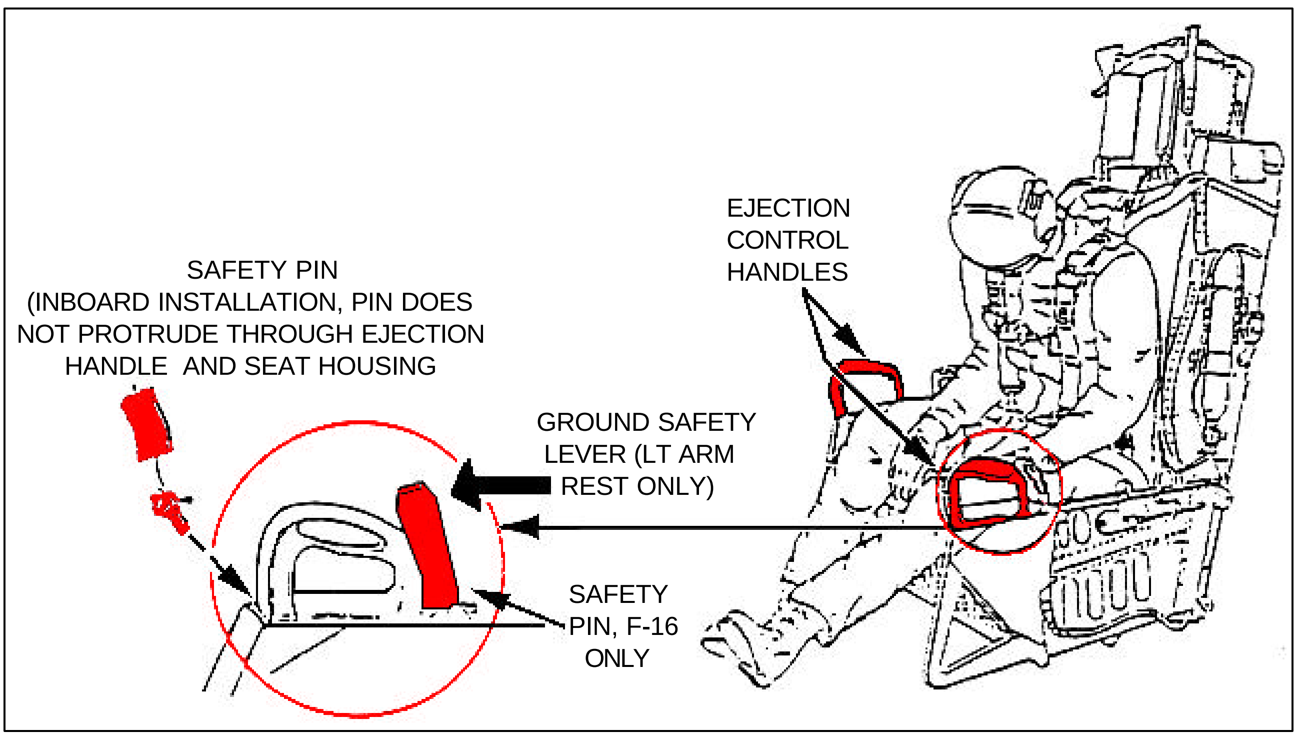


Figure 2-14. ACES II Escape Ejection Seat Showing Methods of Safetying for the A-10, B-1, B-2, F-15, F-22A and F-117. F-16 safety pin is installed at aft bottom of Ground Safety Lever. (See Chapter 8)

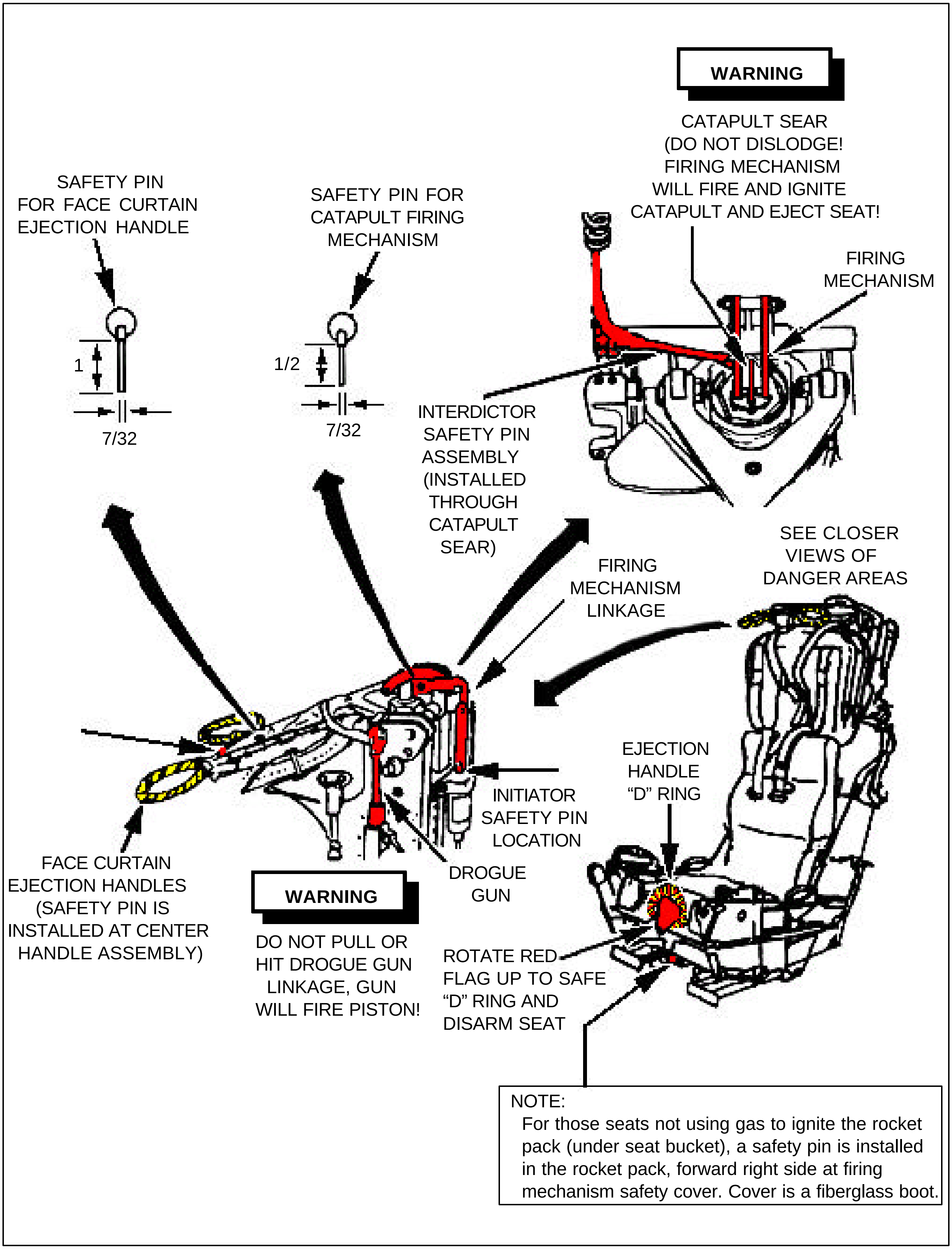
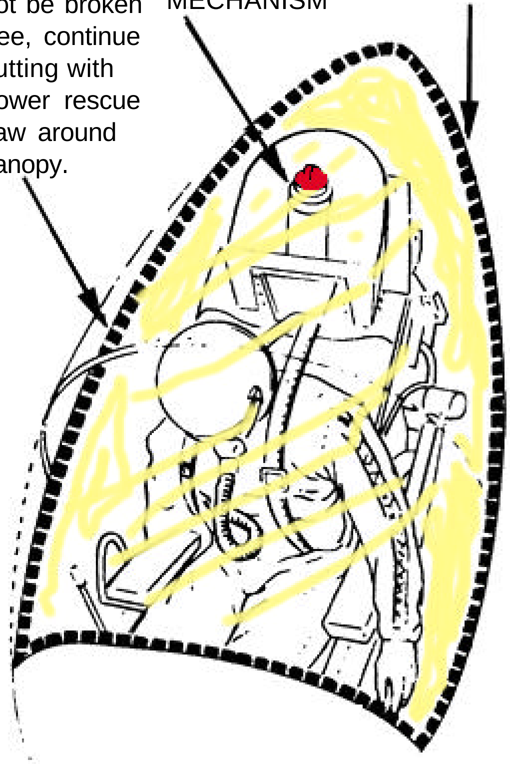


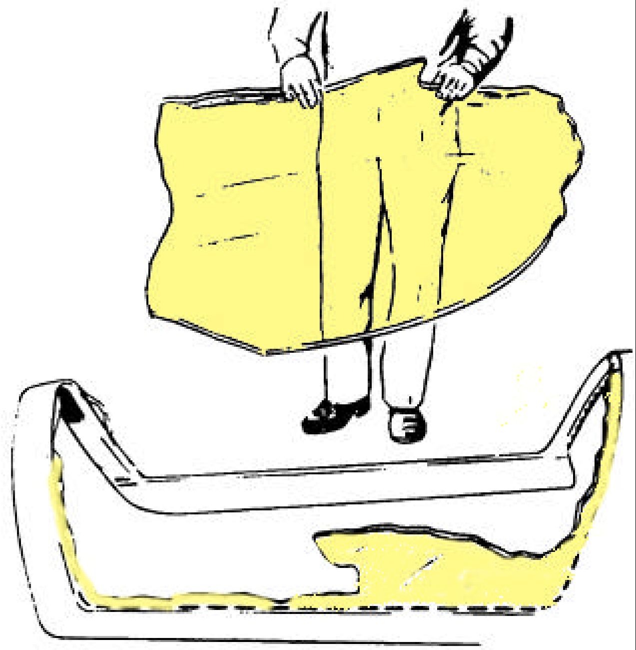
Figure 2-15. Martin-Baker Ejection Seat Showing Disarming Safety Pins and Red Flag



WARNING

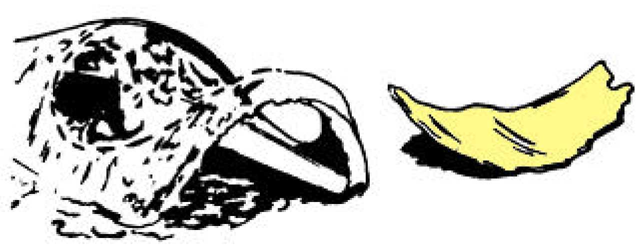
Watch for fragmentation and jagged edges. Edges are very sharp. Fragmentation characteristics differ in type and construction of acrylic plastic.

Figure 2-16. Forcible Entry into Plastic Canopies



NOTE:
Lines denote area cut and the plastic was then grasped and broken free. Note the large section removed and the absence of shattering.

Figure 2-17. Forcible Entry into a Plastic Canopy



NOTE:
Lines denote area cut and the plastic was then grasped and broken free. Note large section removed.

Figure 2-18. Forcible Entry into a Plastic Canopy Exposed to Fire Conditions

2-50. AIRCRAFT HOT WHEEL AND BRAKES.

2-51. Aircraft hot wheel and brakes pose serious considerations for Fire Protection personnel. These considerations are: (1) Danger Zones are areas where exploding wheel, brake and tire assemblies can injure personnel, (2) Safe Zones are areas of approach to the wheels, brakes and tires if a fire is present and requires immediate suppression, and (3) Heat Dissipation times before the wheel and brake assemblies can be safely approached if there has been no fire or damage. (Aircraft tires use fuse plugs designed to melt at a given temperature and relieve tire air pressure.)

The following is general information that is common to most aircraft:

2-52. Danger Zones. Avoid inflated main landing gear tire side area within 300 feet. (See Figure 2-19.)

2-53. Safe Zones. Approach wheel/brake and tire assemblies from the front or rear of assemblies at a 45 degree angle. Munitions loaded on the aircraft must also be taken into consideration when determining the proper approach.

2-54. Heat Dissipation. After aircraft has stopped, wait 30 minutes for the heat in wheel and brake assemblies to dissipate before relocating the aircraft. In a parked condition, and when air circulation is at a minimum, it takes 12 to 15 minutes for brake heat to transfer to the wheel and tire bead. Braking conditions may increase heat and therefore the approach time requirement from 45 to 60 minutes, assuming there is no fire.

2-55. HEATED BRAKE DON'TS.

2-56. There are certain actions the fire department must be aware of and ensure the proper procedures are followed if brakes are in a heated condition. The following DON'TS references TO 4B-1-1:

A. Do NOT Set parking brakes while overheated conditions exist.

B. Do NOT approach landing gear from either side--approach only from the front or rear.

C. After excessive use of brakes, do NOT taxi aircraft after clearing the active runway.

D. Do NOT tow aircraft into a crowded parking area.

E. Do NOT move the aircraft until the brakes have cooled.

WARNING

F. Do NOT attempt to physically determine wheel or brake temperature by mechanical means. (Explanation: extensive research has been shown that there is NO SAFE OR FEASIBLE WAY to mechanically DETERMINE wheel or brake temperature. WHEN A DANGEROUS OVERHEAT CONDITION EXISTS, as a result, the risk to personnel is not warranted.)

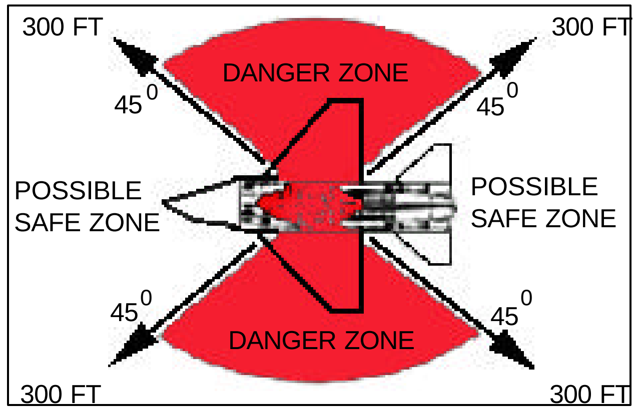


Figure 2-19. F-16 Example

2-57. ENGINE INGESTION OF FIREFIGHTING AGENTS.

2-58. Engine Ingestion of Firefighting Agents: Fire fighters must use **"CAUTION"** to prevent the inadvertent discharge of firefighting agents into aircraft engines and cockpits. Only when it is absolutely necessary for the purposes of preservation of life or the aircraft, should any **firefighting agent** be discharged into the aircraft engine or cockpit area. The chemical composition of firefighting agents can result in a corrosive chemical reaction when in contact with these components. Unnecessary or inadvertent discharge of firefighting agents into these areas can decrease the probability of critical component salvage. Aircraft maintenance personnel must be notified anytime there was a possibility of firefighting agent being discharged into any of these critical components.

2-59. CONFINED SPACES.

2-60. An aircraft confined space is a location on an aircraft or aerospace vehicle where a person can either fully or partially access an internal space. These spaces can also be associated with dangerous equipment or may be a space where breathable air is compromised. AFOSH Standard 91-25 lists the aircraft and areas that meet the definition of a confined space. Requirements of this standard will be applied as appropriate. This list is not all-inclusive and indicates only the minimum aircraft confined spaces.

CHAPTER 3
HAZARDOUS MATERIALS, EVENTS AND RESPONSE PROCEDURES

Note from the Editor:
The information contained in Chapter 3 was provided by the research and compiling efforts of the Air Force Advanced Composites Office (AFRL/MLS-OL) at Hill AFB, UT. This effort could not have been accomplished without the cooperation and countless interviews with aircraft investigators and mishap responders throughout the DoD, who we would like to offer our appreciation and many thanks.

3.1 INTRODUCTION

There are substances found within an aircraft that are known to be hazardous if an exposure occurs. There are non-hazardous materials and situations that can become a hazard during an aircraft mishap response if not handled properly. The presence of hazards may be obvious, as in the case of a fuel spill. In other situations, the hazardous nature of the chemical may not be immediately apparent such as radioactive material. To ensure the safety of the responder, this chapter is dedicated to providing information for the anticipated hazards of an aerospace mishap response. The contents can be used to integrate ORM[1] concepts into the mishap response process. Information needed to quickly identify chemical, flammable liquids and hazardous aerospace materials is found in paragraph 3.3 and 3.4. Hazardous situations encountered at a mishap are found in paragraph 3.5. **Specific mishap response procedures are found in paragraph 3.6.** To help prepare for a response tables and worksheets are found in paragraph 3.7. A review of personal protective equipment choices has been summarized in paragraph 3.8. The appendix contains additional information that could be used for training purposes. Colored coded diagrams depicting hazardous materials and chemicals for each aircraft are provided, starting with Chapter 4.

3.2 DEFINITIONS. Emergency response terms vary within DOD. Terms are defined according to USAF instructions.

a. BLOODBORNE PATHOGEN (BBP). Pathogenic microorganisms that may be present in human blood that cause disease in humans. Infections such as Hepatitis B, Hepatitis C and human immunodeficiency virus (HIV, the virus that causes AIDS) are some examples of BBP.

b. CHAR. A carbonaceous residue formed during pyrolysis or during incomplete combustion. Burnt materials contain surface layers of char.

c. COMPOSITE AND ADVANCED COMPOSITE. A composite is a “system of materials”, made up of two unlike materials, acting as a homogenous solid in its finished form. Two common materials used in aerospace design are a man-made fiber embedded within a matrix. The matrix is a polymeric material or resin consisting of long-chained organic molecules. The fiber provides the strength and the matrix provides toughness and durability while protecting the fibers. Glass fiber dispersed within an epoxy matrix is an example of a conventional composite. Advanced composites use fibers that possess greater strengths than fibers used within a conventional composite system. Examples of an advanced composite are carbon, boron or KevlaR® (aramid) embedded within an epoxy resin.

d. CRISIS ACTION TEAM. Base operation develops a team and procedure that include reaction to downed and missing aircraft.

e. DISASTER CONTROL GROUP (DCG). The response element that deploys to the scene of a major accident to command, control and recover (not aircraft recovery) the site in preparation for the arrival of the investigation board. The DCG is comprised of two subgroups, the initial response group and the follow-on element.

f. DISASTER RESPONSE FORCE. The local organization used for disaster response, command, control and site recovery.

g. DUST. Solid particles (irregular sizes and shapes) generated from disintegration processes such as handling broken or burnt aircraft debris.

h. FIRST RESPONSE. The firefighting response is sometimes called the first response because they reach the mishap scene first. The senior fire officer will serve as the on-scene-commander until the site is declared fire safe and casualties are under medical care.

i. FOLLOW-ON RESPONSE. This disaster control subgroup responds to a preplanned assembly point and deploys when the on-scene-commander determines a safe route to enter the scene. The element may include readiness, bioenvironmental engineering, civil engineering, EOD, aircraft maintenance, ground/flight safety, mortuary affairs, transportation, public affairs, accident investigators and others deemed necessary.

j. FUMES. Solid particles formed by condensation from a gaseous or vapor phase.

k. HAZARDOUS AEROSPACE MATERIALS (HAM). Materials and systems integrated into aerospace vehicles that can present a potential safety and health hazard to personnel responding to mishaps. This includes composites, radar absorbing material (RAM), radioactive material and protective coatings.

l. INITIAL RESPONSE ELEMENT. This disaster control subgroup responds immediately to on or near-base mishap scenes. The element consists of medical, security, fire protection, aircraft maintenance or EOD.

m. RADAR ABSORBING MATERIAL (RAM). There are a number of design parameters used to achieve a low observable (LO) or “stealth” characteristic. One is to use a coating material that is radar absorbing. One type of RAM coating is a polymeric based material loaded

[1] ORM = Operational Risk Management

with a metal or ceramic particles/powder. The older RAM coatings used ferrite as the particle.

n. SECONDARY RESPONSE. When the investigation team releases the site, activity occurs to recover the aircraft and to return the property/real estate to its normal state. The secondary response includes elements that prepare the pieces for shipment, off site aircraft storage, environmental assessment and finally disposal. Even though the emergency response has ceased, potential hazards can still exist for the secondary response elements.

o. SMOKE. Smoke contains airborne solid, liquid and gases evolving when a material undergoes pyrolysis or combustion.

3.3 CHEMICAL AND FLAMMABLE LIQUIDS

This paragraph contains information on known hazardous chemicals and flammable liquids associated with aircraft or aerospace vehicles. A list of vehicles and locations of materials is provided where possible.

a. ANHYDROUS AMMONIA. Anhydrous ammonia is 99.5% by weight ammonia (NH_3) and is a pungent, colorless gas or liquid. Lighter than air. Corrosive to metals.

(1) HEALTH HAZARD. Toxic fluid. Liquid form produces severe frostbite and chemical burns on contact. Gaseous form is a strong irritant and can damage to the eyes and the entire respiratory tract. Vapors are poisonous, may cause death.

(2) FIRST AID. Remove victim from contaminated atmosphere. If skin is contacted, flush the area of contact with large amounts of water, and seek the care of a physician. Remove contaminated clothing and contact lenses.

(3) FIREFIGHTING. Do not add water to liquid ammonia. Containers are BLEVE risk. Entry into an ammonia atmosphere is extremely hazardous. Fire fighting gear including SCBA does not provide adequate protection. If exposure to the chemical occurs, remove and isolate gear immediately and thoroughly decontaminate personnel.

(4) LOCATION. Orbiter Vehicle has two tanks in the aft fuselage.

b. ANTI-ICING FLUID. Anti-icing fluids are usually a mixture of about 85% alcohol and 15% glycerin. Alcohol used in aircraft anti-icing systems burns with an almost invisible flame. The best method of control is by dilution with water or alcohol resistant foam.

c. AQUEOUS FILM FORMING FOAM (AFFF). AFFF is a clear, amber colored liquid. Concentrates consist primarily of synthetic fluorocarbon surfactant materials that are non-corrosive until it is mixed with water.

(1) HEALTH HAZARD. Thermal decomposition of the concentrate produces toxic products such as carbon monoxide, carbon dioxide, oxides of nitrogen, oxides of sulfur, hydrogen cyanide, hydrogen fluoride, and ammonia. If introduced under skin through cuts or punctures, slow-healing ulcers may develop. Eye and skin irritation for prolonged contact. Mist or vapors may cause irritation of the respiratory system, resulting in vomiting, nausea, diarrhea, abdominal pain and stupor. Although ingestion is not an expected route of industrial exposure, it may cause unconsciousness, flushing of face with dizziness, nausea, headache, cough, sore throat, shortness of breath, confusion, convulsions and lethargy.

NOTE

There may be storage concerns relating to contaminated mishap materials/debris in the form of off-gas.

(2) FIRST AID. Immediately flush eyes with plenty of water. Continue for 15 minutes. Flush skin with large amounts of water. If irritations persist call a physician or poison control center. For inhalation, remove victim to fresh air. When ingested call a physician immediately, do not induce vomiting.

(3) FIREFIGHTING. Not applicable. Used as a firefighting agent.

(a) CONCENTRATIONS. These concentrates must meet current military specification standards (MIL-F-24385); three and six percent AFFF concentrate is approved for naval use. Optimum performance for a 3% concentrate is realized when proportioned at 3 parts concentrate to 97 parts water. For a 6% concentrate, optimum performance is achieved when proportioned at 6 parts concentrate to 94 parts water. Current shipboard equipment requires 6% concentrate. When AFFF is mixed with water, corrosive effects occur (particularly saltwater). The AFFF mixture promotes seepage through small cracks, etc. Either fresh water or seawater may be used for proportioning systems. For premixing, only fresh water should be used to reduce corrosion activity. The OPNAVINST 4790.2 series outlines the mandatory procedures that must be followed whenever an aircraft is sprayed with AFFF solution. Unlimited shelf life when stored in a protected area between 32°F (0°C) to 120°F (48°C).

NOTE

Failure to follow manufacturer storage procedures may cause AFFF to break down and separate, degrading its ability to form a vapor seal.

(b) APPLICATION. The unique extinguishing and securing action of AFFF on flammable liquid fires is by a combination of rapid foam blanketing and vapor sealing when applied properly. During fire extinguishment, the AFFF foam blanket rapidly yields a very thin layer of AFFF solution that also extinguishes the fire and forms a vapor seal, restricting further emission of flammable vapors.

NOTE

Application of AFFF fire extinguishing efficiency is not critically dependent on foam expansion as is the case with protein-type foam concentrates. AFFF can be applied with either approved non-air-aspirating nozzles or air-aspirating foam nozzles. However, the variable stream fog nozzle type is preferred because of the rapid stream adjustability afforded the firefighter. Additionally, these nozzles produce more foam, resulting in faster control and extinguishment. AFFF is compatible with Halon 1211 and PKP dry chemical firefighting agents.

WARNING

Periodic reapplication of AFFF is essential to avoid re-flash when working in and around crashed aircraft.

(4) LOCATION. AFFF will be found on trucks, some suppression systems in hanger.

d. BERYLLIUM. Beryllium as a dust or powder form is a silvery looking material resembling aluminum powder. As a solid, it is a hard brittle gray-white metal.

(1) HEALTH HAZARD. Dust is a toxic respiratory and eye irritant. If introduced under skin through cuts or punctures, slow-healing ulcers may develop. Dust is highly toxic.

(2) FIRST AID. After exposure to beryllium fire, personnel should bathe carefully and all equipment and clothing should be laundered separately from other non-contaminated material and clothing.

(3) FIREFIGHTING. Dust forms explosive mixtures in air. Hazard is greater as particle fineness increases. Reacts readily with some strong acids, producing hydrogen.

(4) LOCATION. C-5 brake pads, F-100 wingtip area and around cockpit, the A-7D landing gear bushings (older aircraft may still be in use), solid rocket propellant, gyroscopes and inertial guidance systems.

e. ETHYLENE GLYCOL. Ethylene glycol is clear viscous liquid with a slight odor and sweet taste. Used for liquid controls, calibrators, coolant, and in some de-icing fluids.

(1) HEALTH HAZARD. Inhalation can cause irritation of mucous membranes and respiratory passages. Ingestion may cause intoxication and coma. Skin contact causes irritation.

(2) FIRST AID. For skin, wash affected areas thoroughly. For ingestion, eyes, or contact with open wound, obtain medical attention in all cases.

(3) FIREFIGHTING. Stable, but heat should be avoided. Materials to avoid: strong oxidizers.

(4) LOCATION. Various aircraft.

f. FC-77. FC-77 is a non-reactive, non-corrosive, non-flammable, inert liquid. When heated above 572°F or when electricity is passed through the solution some forms of nerve gas may evolve.

(1) HEALTH HAZARD. Prolonged skin or eye exposures can cause dermatitis. Thermal decomposition creates toxic by-products, such as hydrogen fluoride and perfluoroisobutylene.

(2) FIRST AID. Flush eyes with plenty of water. Call a physician. Wash affected skin area with soap and water. Do no breathe vapors. If exposed to thermal decomposition products move victim to fresh air. Call a physician.

(2) FIREFIGHTING. Non-flammable. SCBA will be worn when exposed to thermal decomposing FC-77 atmosphere.

(3) AIRCRAFT AND LOCATION. E-3, used to cool radar system.

g. FREON - 502 REFRIGERANT. Freon is a clear, colorless liquefied gas with a slight ether odor. Used for cooling and refrigeration systems. Freon 502 is a mixture of Freon 115 and 22.

(1) HEALTH HAZARD. Overexposure by inhalation may include discomfort, nausea, headache, weakness, temporary nervous system depression with anesthetic effects like dizziness, confusion, loss of coordination, or consciousness. Gross overexposure (>20%), possible temporary alternation of the heart's electrical activity with irregular pulse, palpitations, inadequate circulation. Misuse can result in death.

(2) FIRST AID. Get fresh air. Keep calm. If breathing stops, give artificial respiration. If difficult, give oxygen and call a physician. Eyes and skin contact: flush with water for 15 minutes.

(3) FIRE HAZARDS. Will not burn. Cylinders are equipped with temperature and pressure relief devices, but still may rupture under fire conditions (BLEVE). Avoid open flames and high temperatures. Materials to avoid: alkali or alkaline earth metals -powered Al, An, Be, etc. Decomposition is HF, HCl and carbonyl halides. SCBA is required if cylinders rupture or release under fire conditions. Use neoprene rubber glove and eye protection for chemical splash concerns.

(4) LOCATION. Multiply aircraft.

h. HALON 1301. Bromotrifluoromethane. Halons are firefighting agents that are being phased out.

(1) HEALTH HAZARD. Skin contact causes defatting of skin. Decomposition in flame or hot surface produces toxic fluorocarbons. Vapors are heavier than air and concentrate in low-lying areas. Inhalation of concentrated vapors can be fatal. Low concentration exposure causes eye, nose, and throat irritation. Palpitations, light-headedness and headaches are also seen. High concentrations occurring in poorly ventilated areas have been associated with ventricular arrhythmias, pulmonary edema and sudden death. Oral and inhalation exposure may cause frostbite.

(2) FIRST AID. Move victim to fresh air. Irrigate exposed eyes with copious amounts of water for 15 minutes. Remove contaminated clothing and wash exposed area with soap and water. See medical attention for frost bite.

(3) FIREFIGHTING. Halon 1301 is not flammable and does not ignite readily. Containers may explode when heated. Fight fires with SCBA. Structural firefighters' protective clothing will only provide limited protection.

(4) LOCATION. Found in fire extinguishers.

i. HYDRAZINE. Hydrazine at room temperature is a clear, oily, fuming, liquid with an odor similar to ammonia. It is hazardous to health in both the liquid and vapor form; combustible and explosive. Hydrazine fuel (H-70) is a blend of 70% hydrazine and 30% water. Used to power the EPU on F-l6 series aircraft. EPU operation results in noise similar to the rapid firing of a rifle. Exhaust gases exiting from the EPU turbine are approximately 1600°F (87l°C) and basically consist of 40% ammonia, 17% nitrogen, 15% hydrogen, and 28% water. See page F-16.4 for hydrazine bottle view.

(1) HEALTH HAZARD. Hydrazine is highly alkaline and causes severe local damage or burns in contact with eyes or skin. It can penetrate skin to cause systemic effects similar to those produced when swallowed or inhaled. If inhaled, the vapor causes local irritation of eye and respiratory tract. Short exposure causes systemic effects involving the central nervous system with symptoms including tremors. Exposures to high concentrations cause convulsions and possible death follow. Repeated or prolonged exposures may cause damage to the liver and kidneys, as well as anemia.

(2) FIRST AID. Entry into a hydrazine atmosphere is extremely hazardous and only warranted in dire emergency. Remove the victim from the contaminated environment; remove all contaminated clothing and wash propellant from the skin with water. If eyes have been exposed, flush with water for at least 15 minutes and get immediate medical attention. Emergency limits for exposure to hydrazine vapors are in concentrations of 30 parts per million for 10 minutes, 20 PPM for 30 minutes, and 10 PPM for 60 minutes. Irreversible health effects occur at 80 PPM for 30 minutes. Such high concentrations are only attainable in enclosed areas like a hangar and cannot be achieved in open air.

(3) FIREFIGHTING. Hydrazine is a strong reducing agent. It is hypergolic with oxidizers such as nitrogen tetroxide and metal oxides of iron, copper, lead, etc. Spontaneous ignition may occur if it is absorbed in rags, cotton waste, etc. Hydrazine will ignite when exposed to heat, flame or oxidizing agents. The flashpoint is 126°F (52°C). As opposed to liquid form, hydrazine vapors as much more sensitive to electrical sparks, embers, flame, etc. Move container to area from fire area if possible without risk. Ignited vapor will continue to burn exothermically without air or other oxidants. Decomposition starts exothermically at 320°F. Spray cooling water on containers exposed to flame or smoldering debris until well after fire is out. Firefighting instructions are contained in USAF Technical Orders T.O. 42Bl-1-18. General Procedures for handling of H-70, Hydrazine-Water is found in T.O. IF-16C-2-49GS-OO- 1.

(4) LOCATION. The F-16 has 6.8 and the Orbiter Vehicle has 1676 US gallons.

j. HYDROGEN-LIQUID. A non-toxic, non-corrosive, transparent, colorless, odorless liquid of low viscosity.

(1) HEALTH HAZARD. In gaseous form, hydrogen acts as a simple asphyxiant. If in very high concentration, atmospheric oxygen content may be reduced and oxygen deprivation will result. Contact with skin can cause serious burns.

(2) FIRST AID. If contact with skin occurs, flush affected area with water. Extensive burns will require prompt medical attention.

(3) FIREFIGHTING. Hydrogen gas is highly combustible with air over a wide range of mixtures and will explode when heated. When no impurities are present, hydrogen burns in air with an invisible flame. Liquid hydrogen evaporates rapidly. Consequently, fires are of short duration. Vapors are heavier than air and spreads on and around the affected area and low spots. May travel back to source of ignition and flash back. Approved respiratory protection shall be worn. Self-contained breathing equipment that uses oxygen should be of the re-breathing type to minimize release of oxygen to the atmosphere. If demand-type equipment is used, compressed air must be used.

(4) LOCATION. Orbiter Vehicle has two tanks in the middle of the fuselage.

k. HYPERGOLIC MIXTURES. Hypergolic mixtures are used as propellants. Hypergolic fuels ignite on contact with certain chemical oxidizers and do not require an ignition source. Examples of hypergolic combinations used missile/rocket propulsion systems are:

MIXTURE NO.1. Fuels: ammonia, hydrazine, hydrogen. Oxidizers: fluorine or chlorine trifluoride.

MIXTURE NO.2. Fuels: hydrazine, analine, furfuryl alcohol, deta hydrazine. Oxidizers: nitric acid.

MIXTURE NO.3. Fuels: hydrazine, unsymmetrical dimethyl-hydrazine. Oxidizers: hydrogen peroxide.

MIXTURE NO.4. Fuels: aniline, hydrazine, furfuryl alcohol. Oxidizers: nitrogen tetroxide.

(1) HEALTH HAZARDS. The health hazards include chemical burns, poisoning, and frostbite.

(2) FIRST AID. Provide aid based on the chemical and the exposure scenario, individual components or mixuture.

(3) FIREFIGHTING. Fires involving these materials can best be handled by diluting the fuel and oxidizer with large quantities of water.

(4) LOCATION. Propellants in various rockets and missiles.

l. JET FUELS. Jet Propulsion/aviation turbine fuels are amber in color and are a hydrocarbon based fuel. Fuel types are:

AVGAS. The flashpoint (by closed cup method at sea level) of AVGAS is -50°F (-46°C). The rate of flame spread has been calculated to be between 700 and 800 feet per minute.

JP-4. JP-4 jet fuel is a blend of gasoline and kerosene and has a flashpoint from -10°F (-23°C). The rate of flame spread has also been calculated to be between 700 to 800 feet per minute.

JP-5. JP-5 fuel is a kerosene grade with a flashpoint of 150°F (66°C). The rate of flame spread has been calculated to be in the order of 100 feet per minute.

JP-8. JP-8 is a kerosene grade with a flashpoint of 115°F (approximately 46°C). The rate of flame spread is in the order of l00 feet per minute. The lowest flashpoint considered safe for use aboard naval vessels is 140°F (60°C).

(1) HEALTH HAZARD. Irritates or burns skin and eyes. Fire will produce irritating, corrosive and/or toxic gases. Vapor may cause dizziness or suffocation. Run off from fire control may cause pollution.

(2) FIRST AID. Remove victim from area and then get immediate medical attention. Removed contaminated clothing and wash exposed areas.

(3) FIREFIGHTING. Although there are differences in the properties, it must be emphasized that under aircraft crash impact conditions where fuel mists (fuel-air mixture) are created, all of the fuels are easily and readily ignitable. There is so little difference in the heat of combustion between the various aircraft hydrocarbon fuels that the severity after ignition would be of no significance from the fire safety point of view. The firefighting and control measures are the same for the entire group of aviation hydrocarbon fuels. Approved SCBA respiratory protection shall be worn. Structural firefighters will only provide limited protection.

WARNING

As little as a 2.5 % mixture of JP-4, JP-8, or commercial equivalent in JP-5 greatly reduce the flashpoint below 140°F. Aircraft that have refueled in flight or ashore from Air Force, civilian, or Army facilities may contain unsafe fuel mixtures.

NOTE

As little as a 2.5 % mixture of JP-4 in JP-5 will reduce the flashpoint by 40°F (5°C). 10% JP-4 reduces the flashpoint of the mixture by 90°F (32°C).

(4) LOCATION. All aircraft throughout this publication.

m. KAPTON®. A polyimide film coated with polyfluorocarbon that is used as an electrical insulation material. Some uses are wire and cable insulator, radiation shield and insulation blanket.

(1) HEALTH HAZARD. Heating Kapton® above 527°F or from smoking cigarettes contaminated with fluorocarbon coatings may cause polymer fume fever, a temporary, flu-like illness of approximately 24 hours duration with fever, chills and sometimes cough. Exposure to temperature above 662°F produces trace amounts of carbonyl fluoride, perfluorisobutylene causing severe eye, skin and respiratory tract irritation. Inhalation can cause shortness of breath and other respiratory effects and symptom may be delayed. Handling Kapton® films produces static charge.

(2) FIRST AID. Move to fresh air. Wash with soap and water when skin contact is made with burnt debris. If skin irritation develops or symptoms persist contact or consult a physician.

(3) FIREFIGHTING. The polyimide film is self-extinguishing. Kapton® chars, but does not burn in air. Extinguish with foam. Wear SCBA and clothing to protect from hydrogen fluoride. HF will react with water to form hydrofluoric acid. Wear neoprene gloves when handling refuse from a fire involving fluorocarbon resins.

(4) LOCATION. Various aircraft.

n. LITHIUM THIONYL CHLORIDE. A soft, silvery, slightly reactive metallic element, used as a heat transfer medium in thermonuclear weapons and in alloys.

(1) HEALTH HAZARD. Serious injury to personnel can occur if incorrect fire suppression procedures are ignored, such as using Halon.

(2) FIRST AID. Remove victim from area and then remove all contaminated clothing with protective gloves. Get immediate medical attention.

(3) FIREFIGHTING. SCBA is used. Lithium metal and thionyl chloride reacts violently with water. Use only a graphite powder such as Lith-X. Never use water, wet sand, carbon tetrachloride, carbon dioxide, or any other liquid or powder to extinguish a lithium fire

(4) LOCATION. Various aircraft, on-board mission computer batteries.

o. LUBRICATING OIL. Hydrocarbon based oil with the addition of corrosion and oxidation inhibitors. See Skydrol.

p. MAGNESIUM. Magnesium is a silvery-white metal that looks like aluminum, but weighs less.

(1) HEALTH HAZARD. Magnesium dust is a slight irritant. In fire conditions, protect eyes and skin against flying particles. Avoid direct viewing of magnesium fires as eye injury may result. Fire produces toxic gas.

(2) FIRST AID. If burns are received, contact a physician. Creates a corrosive solution in contact with water. Treat skin contact for corrosive burns.

(3) FIREFIGHTING. Do not use water, Halon or foam. Fine powder, thin sheets, chips and trimmings, are easily ignited and burn with intense heat and brilliant white flame. Pieces having thickness over 1/8 inch are difficult to ignite or to maintain flame as heat is conducted away so rapidly. However, thick pieces can be ignited when enough heat is applied. In finely divided form, will react with water and acids to release hydrogen; also hazardous in such form with chlorine, bromine, iodine, oxidizing agents, and acids. Produces flammable gases in contact with water.

(4) LOCATION. Magnesium parts are located on most aircraft in different locations. One major use is in wheel assemblies.

q. NITROGEN TETROXIDE. Pressurized liquid (mixture of N_2O_4 and NO_2) - is a strong oxidizer.

(1) HEALTH HAZARD. Skin contact with liquid form will cause burns similar to nitric acid. Eye contact may cause blindness. If swallowed, may result in death from severe internal burns. Prolonged inhalation will result in irritation of respiratory tract and may cause pulmonary edema. Toxic, may be fatal if absorbed through skin or inhaled.

(2) FIRST AID. Remove victim from contaminated area and then carefully remove all contaminated clothing. Rinse victim with copious amounts of water. Get immediate medical attention.

3) FIREFIGHTING. Noncombustible but supports combustion. Contain fire and let burn. If fire has to be fought, use water only. Level A fully encapsulated suit for vapor protection entry into a nitrogen tetroxide atmosphere.

(4). LOCATION. Orbiter Vehicle has one tank in nose and four in aft section.

r. OXYGEN - GASEOUS AND LIQUID. Oxygen is a powerful oxidizer in the liquid and gaseous states. It is colorless, odorless, and slightly heavier than air. In the liquid state, it is pale blue in color and denser than water.

(1) HEALTH HAZARD. The oxygen rich atmosphere can be ignited by an ignition source. Oxygen in the liquid state is generally less dangerous than oxygen stored as a gas. Liquid oxygen boils (vaporizes) at minus 297°F, and will freeze any object that comes in contact with it.

(2) FIRST AID. If liquid oxygen contacts the skin, flush affected area with water; contact a physician.

(3) FIREFIGHTING. Non-flammable in normal concentrations; however, it reacts vigorously with both flammable and many non-flammable materials. Fight surrounding fire with an agent appropriate for the burning material. Stop the release if it can be done safely from a distance.

(4) LOCATION Oxygen is located in different places aboard the aircraft and of various amounts. See aircraft diagrams for location starting with Chapter 4.

s. POLYACRYLIC ACID (PAA). One type of PAA is a hydrotreated light distillate petroleum with a white semi-solid appearance with a slight odor. Common name: Easy Glaze. Used as a particulate hold-down solution on broken up aircraft materials that are prone to becoming airborne.

(1) HEALTH HAZARD. Inhalation causes dizziness, abdominal discomfort, central nervous system depression, headache, nausea and mucous membrane irritation. Eye contact can cause conjunctivitis. Skin/ingestion contact causes irritations.

NOTE

PAA can be an environmental hazard. Concentrated fixant may have a pH characteristic of a hazardous waste. Do not overspray objects, fixant contaminates. The ground may become a hazardous waste concern during the environmental assessment process.

(2) FIRST AID. Wash skin and hands after use. If ingested, do not induce vomiting. Give water. Obtain medical attention in all cases.

(3) FIREFIGHTING.Flashpoint 200°F. Extinguishing media: CO2, foam, dry chemical, or water. Wear SCBA in positive pressure mode and full protective gear. Conditions to avoid: heat sources, sparks, flame, freezing. Materials to avoid: oxidizing agents and acids. Store between 40° and 120°F and use in properly ventilated areas.

(4) Wherever composite wreckage is.

t. POLYALPHAOLEFIN. PAO listed as MIL-PRF-87252, is a synthetic hydrocarbon lubricating base oil used as a dielectric coolant. Appearance is clear and has no odor. Manufactured under trade name of Royco 602.

(1) HEALTH HAZARD. Mildly irritating to the skin, prolonged or repeated liquid contact can result in defatting and drying of the skin which may result in skin irritation and dermatitis. Released during high-pressure usage may result in injection of oil into the skin causing local necrosis. Inhalation of vapors (at high temperatures only) or oil mist may cause mild irritation of the mucous membrane upper respiratory tract. May be harmful or fatal if swallowed. Ingestion may result in vomiting. Signs and symptoms of exposure are irritation/aspiration. Pneumonitis may be evidenced by coughing, labored breathing and cyanosis (bluish skin). In severe cases, death may occur. Local necrosis is evidenced by delayed onset of pain and tissue damage a few hours following injection.

(2) FIRST AID. Flush eyes with water. Remove contaminated clothing/shoes and wipe excess from skin. Flush skin with water. Follow by washing with soap and water. Do not reuse clothing until cleaned. If material is injected under the skin, get medical attention promptly to prevent serious injury. Remove victim to fresh air and provide oxygen if breathing is difficult. For ingestion, do not induce vomiting. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lung. Get medical attention for all above exposures.

(3) FIREFIGHTING. Flash point is 350°F. Product will float and can be re-ignited on surface of water. Release on hot surfaces will cause a fire. Use water fog, foam, dry chemical or CO_2. Do not use a direct stream of water. Material will not burn unless preheated. Do not enter confined fire space without full PPE. Cool fire exposed containers with water. Thermal decomposition products are highly dependent on the combustion conditions. A complex mixture of airborne solid, liquid, particulates and gases will evolve when this material undergoes pyrolysis or combustion. Carbon monoxide and other unidentified organic compounds may be formed upon combustion. Keep away from open flames and high temperatures.

(4) LOCATION. Used in all military aircraft as a coolant for avionics, radar, and radar counter-measure systems since the 1970s. Replaced former coolants for this purpose.

u. QUARTZ. Silicon dioxide or silica. Used in composite systems as a fiber or particle.

(1) HEALTH HAZARD. Long-term exposure to inhaled crystalline silica (silicon dioxide, SiO_2) in the form of quartz has shown to be carcinogenic in humans. Skin, eye and respiratory irritations can occur from exposure to dust containing silica. Dust can be

generated when crushing, grinding, cutting or handling severely damaged and shattered parts containing quartz. Pure quartz is chemically and biologically inert when ingested in any of its physical forms.

(2) FIRST AID. Move patient to fresh air. Monitor for respiratory distress. If cough or difficulty breathing develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. Irrigate exposed eyes with copious amounts of tepid water for 15 minutes. If irritation, pain, swelling persists, seek medical attention. Wash exposed dermal area with soap and water.

(3) FIREFIGHTING. Rescuers do not enter areas with potential high airborne particulate concentrations without SCBA.

(4) LOCATIONS. High purity silica or quartz can be found in plastic and resin materials as filler in particulate form. Fibrous quartz material can be used to make antenna windows, radomes, ablative and ablative and thermal barriers. B-1, B-2, F-15, F-117, F-22 radome. Replacement radome material for F-16 and may be found in some commercial aircraft.

v. SKYDROL LD-4 and 5. Used as a hydraulic fluid and is fire resistant under normal conditions and not fire resistant in a mishap. Appearance is clear, purple oily liquid and odorless. Considered environmentally friendly and non-cancer causing, precautions should be maintained.

(1) HEALTH HAZARD. Target organs: eyes, skin, respiratory and gastrointestinal tracts. Acute-eye causes severe pain. Skin: prolonged/repeated contact may cause drying and cracking. Vapors or mists may cause respiratory irritation. Inhalation of tributyl phosphate, a component, may cause nausea and headache. May be harmful if ingested. Chronic exposure may cause urinary bladder damage based on animal studies. Signs and symptoms of overexposure are: irritation, redness, nausea, vomiting, blurred vision, tearing, de-fatting of skin, headache, cracking. Products of combustion include hazardous carbon monoxide, carbon dioxide and oxides of phosphorus. Exposure to strong oxidizing agents may result in generation of heat and combustion products. Oxides of phosphorus may form during decomposition. No other uniquely hazardous decomposition products are expected. Product is stable under of use up to approximately 250 - 275°F.

NOTE

For splashes or spills at a mishap site, wear protective clothing. Launder or destroy contaminated clothing. Have eye-flushing equipment available. Prevent exposure to inhalation wash after handling contaminated equipment, and clean contaminated clothing.

(2) FIRST AID. If in eyes, immediately flush with plenty of water for at least 15 minutes. Get medical attention. Skin contact requires flushing immediately with plenty of water. Remove contaminated clothing. Get medical attention. Wash clothing before reuse. If inhaled move to fresh air. If not breathing, provide artificial respiration. If breathing is difficult, give oxygen. Get medical attention. If swallowed contact physician or poison control center.

(3) FIREFIGHTING. Extinguishing media is waters spray, carbon dioxide, sand, foam/dry chemical or any Class B extinguishing agent. Water spray may be used to keep fire-exposed containers cool. Firefighters will wear full protective clothing including SCBA.

(4) LOCATION. Various aircraft now have Skydrol installed in systems and reservoirs.

w. SULFURHEXAFLOURIDE GAS (SF-6). SF-6 is colorless, tasteless, and non-toxic. Heavier than air and is non-flammable and non-corrosive. This gas reacts with water to form hydrofluoric acid.

(1) HEALTH HAZARD. SF-6 is a simple asphyxiant that displaces oxygen in the lungs and causes suffocation.

(2) FIRST AID. Remove victim to fresh air. Seek medical attention.

(3) FIREFIGHTING. Non-flammable. Entry into a SF-6 atmosphere is extremely hazardous. Level A suit is required at all times.

(4) LOCATION. E-3A, aft lower lobe.

x. TRIETHYLBORANE (TEB). Used as a fuel additive to provide rapid ignition of non-hyperbolic fuel or propellant. Extremely toxic volatile liquid with a sweet pungent odor.

(1) HEALTH HAZARD. Harmful by inhalation, ingestion, or skin absorption. TEB contact with the skin or eyes will cause deep thermal burns. Hazardous combustion products are CO, CO_2, boron, and boron oxide.

NOTE

Inhalation of vapor may be unlikely since spontaneous ignition occurs at lower concentrations than those required to cause toxic reactions.

(2) FIRST AID. In case of contact, immediately flush eyes or skin with copious amounts of water for at least

15 minutes while removing contaminated clothing and shoes. Move to fresh air.

(3) FIREFIGHTING. Pyrophoric. Detonations or violent reactions may occur when TEB comes in contact with strong oxidizing agents or halogenated hydrocarbons. Catches fire if exposed to air. Use dry chemical foam. When the foam blanket is broken, re-ignition usually occurs. Carbon dioxide and inert gas can also be used to combat TEB fires. Do not use Halon to extinguish TEB fires. Emits toxic fumes under fire conditions. Wear SCBA and full protective clothing.

(4) LOCATION. TEB is used on the SR-71 during high altitude operations. A 700cc TEB tank is mounted on the upper left side of each engine.

y. TRICRESYL PHOSPHATE. TCP listed as MIL-L-23699E, is a synthetic hydrocarbon and is a lubricating oil additive. Appearance is liquid, brown in color with a mild odor. Manufactured under the trade name of Mobil Jet Oil 254.

(1) HEALTH HAZARD. This product is determined to be hazardous, but is not expected to produce neurotoxic effects under normal conditions of use and with appropriate personal hygiene practices. Avoid inhalation of mists. Overexposure to TCP by swallowing, prolonged or repeated breathing of oil mist, or prolonged or repeated skin contact may produce nervous system disorders including gastrointestinal disturbances, numbness, muscular cramps, weakness and paralysis. Paralysis may be delayed. Wash thoroughly before eating or smoking. Keep away from feed or food products. Do not use on food processing machinery. Store in a cool, dry, well-ventilated area away from heat.

(2) FIRST AID. For eye contact, flush eyes with water. For skin contact, wash contact area with soap and water. Do not wear ordinary clothing wet with this product. Remove contaminated clothing. Do not reuse clothing until cleaned. For inhalation, remove victim from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with bag-valve-mask device or use mouth-to-mouth resuscitation. For ingestion, seek immediate medical attention. If medical attention will be delayed, contact a Region Poison Center or emergency medical professional regarding the induction of vomiting or use of activated charcoal. Do not induce vomiting or give anything by mouth to a groggy or unconscious person. Get medical attention for all above exposures.

(3) FIREFIGHTING. Flash point is 475°F. Unusual fire or explosion hazard: none. Extinguishing media: carbon dioxide, foam, dry chemical and water fog. Water or foam may cause frothing. Use water to keep fire exposed container cool. Water spray may be used to flush spills away from exposure. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. For fires in enclosed areas, use SCBA. Hazardous decomposition: carbon monoxide.

(4) LOCATION. Used on military and commercial aircraft gas turbine engines of the turbo-jet fan, turbo-prop, and turbo-shaft (helicopter) types.

3.4 HAZARDOUS AEROSPACE MATERIALS (HAM)

This paragraph provides information for radioactive, composite, radar absorbing, and coating materials useful for the initial or follow-on response phase of an incident. The information includes potential health hazards, fire hazards and emergency actions to take in the event of fire with appropriate first aid measures.

1. RADIOACTIVE MATERIALS (See appendices for additional information).

a. ALLOYS: MAGNESIUM-THORIUM, NICKLE-THORIUM, AND NICKLE. Alloys containing 2.5-4% thorium have been determined to have toxic properties. These are as a chemical hazard comparable to mercury in its toxicity and as a radiation hazard.

(1) HEALTH HAZARD. This product is determined to be hazardous, but is not expected to produce neurotoxic effects under normal conditions of use and with appropriate personal hygiene practices. Avoid inhalation of mists. Overexposure to TCP by swallowing, prolonged or repeated breathing of oil mist, or prolonged or repeated skin contact may produce nervous system disorders including gastrointestinal disturbances, numbness, muscular cramps, weakness and paralysis. Paralysis may be delayed. Wash thoroughly before eating or smoking. Keep away from feed or food products. Do not use on food processing machinery. Store in a cool, dry, well-ventilated area away from heat.

(2) FIRST AID. Keep dust particles and fumes away from eyes, skin, and lungs. Wear full PPE where atmosphere has been compromised, such as a work place where the exhaust system has failed or ventilation is suspect. Isotope Mesothorium I can be inhaled deposited in the bones and irradiates the lungs excessively if not controlled. Local tissue damage and accompanying shock can result. Absorption can result in slight changes in the blood and bone through internal radiation. If personnel have been exposed, get immediate medical attention. Wash hands immediately after handling the alloy and before eating.

(3) FIREFIGHTING. Hazards can occur during manufacturing such as chemical milling, pickling, or melting, welding and filing or when separation of thorium from its radioactive daughters takes place and dust particles can become airborne. In most cases, an exhaust system will be in use during these processes. Thorium fume and radioactivity will also be present during these processes. In the event of a devastating aircraft accident, particles can be released under the like above conditions.

(4) LOCATION. Used on certain parts (inlet transfer and rear gearboxes) of the J-79-8/-10/-15/-17 engine and fabricated with magnesium-thorium alloy containing 2.5 to 4% thorium by weight. Each engine part, or group of parts, or smallest integrated subassembly containing up to 4% thorium must be accompanied with a special radioactive material tag or sheet before any chemical, physical, or metallurgical processing is done.

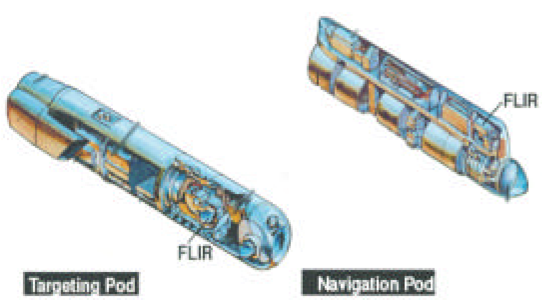
b. AMERICIUM - 241. A synthetic radioactive metallic element. Metallic americium is silver-white with a melting point of 210°F.

(1) HEALTH HAZARDS. Americium is a gamma and an alpha emitter, radioactive poison. AM-241 emittance is approximately 5 MeV; Gamma emittance is approximately 60KeV. Destruction of the FLIR unit is needed for an AM-241 exposure (severe crash). The pod may become damaged during impact and expose the AM-241 coated contents of the FLIR. Handling of the optical module includes wearing gloves and a properly fitted protective mask while double sealing it in plastic bags or containerizing it. Keep unnecessary people out of incident area until area is declared safe by the radiological response team.

(2) FIRST AID. Wash away any material that may have contacted the body with copious amounts of water or soap and water.

(3) FIREFIGHTING. If the material is on fire keep upwind, avoid breathing dust and fumes.

(4) LOCATION. AM-241 is found within the LANTIRN (Low Altitude Navigation and Targeting Infrared for Night) system in the F-18 A/B/C/D. The material is located in the forward-looking infrared pod (FLIR).



c. DEPLETED URANIUM (DU). Used as ballast or counterweights in aircraft gyroscopes, flight controls, helicopter blades, elevator balances, aileron balances, aircraft rockets, projectiles and missiles. DU is natural uranium having most of the U-234 and U-235 removed; it is principally U-238. It is a heavy metal that oxidizes taking on a yellow color and then a black color. To avoid oxidation, the DU is cadmium plated. Some DU is conversion coated and has a gold or brass color. A problem arising from damaged plating is flaking from formed uranium oxidation. More information is found in Appendix A.

(1) HEALTH HAZARDS. DU presents a two-fold hazard, chemical and radiation.

(a) The chemical properties of DU present a health hazard only after entry into the body by inhalation, ingestion, or through an open wound. Inhalation is the most significant mode of entry. If involved in fire, DU will give off very toxic fumes. Once oxidized DU is deposited in the respiratory tract, it can be taken into the blood stream and deposited in internal organs where damage may result. Most dusts from DU, in the body, are relatively insoluble and not as hazardous as the soluble forms.

(b) DU provides both an internal and external radiation hazard. When taken into the body, intense ionization produced by the alpha particles may cause severe localized damage to cells. Externally, the beta radiation is classified as a skin exposure. Given these limits, DU does not constitute a serious external radiation hazard. The beta radiation exposure to the extremities can be reduced up to 50% by wearing leather gloves. A few feet away, there is little radiation exposure for beta and or gamma.

(2) FIRST AID. Contact physician if there was a potential exposure.

(a) RADIATION MEASUREMENT. Radiation surveys to detect the presence of DU in disassembled aircraft can be accomplished by using a Ludlum model 3 or 18 meter in conjunction with an Eberline model HP260 GM probe or a XETEX model 308 radiation detector. Pancake type probes provide excellent results for aircraft surveys.

(b) HANDLING INSTRUCTIONS.

1 No drilling, filing, machining, sanding, or other abrasive procedure is permitted.

2 Where prolonged body contact is possible or where abrasive operations are likely to affect the DU, it will be removed and stored in a secure area.

3 Skin contact should be avoided. Thick gloves should be worn if handling is required. DU with damaged plating will be wrapped and sealed in plastic bags or wrapping material.

4 Industrial eye protection and approved respirators will be worn when removing and handling damaged or corroded DU.

5 Materials used in handling corroded or damaged DU (such as gloves or plastic wrap) will be bagged in plastic and placed in radioactive waste containers for disposal IAW applicable technical orders.

6 Personnel handling DU will wash hands thoroughly with soap and water immediately after removal of gloves, before eating, drinking, smoking or at the end of the shift.

7 The Radiation Safety Officer should survey areas where corroded DU has been handled or stored. Periodic surveys should be accomplished for all DU storage or work areas.

(3) FIREFIGHTING. Fire or explosion: Some of these materials may burn, but most do not ignite readily. Uranium and thorium granules may ignite spontaneously if exposed to air. SCBA and full protective clothing is required.

(4) LOCATION. A-10, C-5, C-130, C-140, C-141, F-16, H-3, DC/KC-10, L-1011, 747

d. KRYPTON - 85. A colorless and odorless inert gas.

(1) HEALTH HAZARDS. Krypton is beta and gamma producing material. The need to enclose Krypton gas in a metallic container for aircraft use significantly reduces the beta hazards. However, due to the nature of gamma radiation, this is a primary hazard. The safety procedures for gamma radiation are distance and limiting physical contact.

NOTE

The gas is contained in a metal tube that is partitioned; therefore, a break may allow the gas to escape.

(2) FIRST AID. Seek medical attention immediately.

(a) HANDLING PROCEDURES.

1 Maintain minimum of three feet distance from the source, when possible.

2 When transporting the source, use an approved container (do not keep container with source in the passenger section of vehicle).

3 Use mechanical fingers when physically handling the source, when possible. Personal contact should be kept to the minimum.

4 If a tube source should break: clear the area, go upwind and notify the following:

- Maintenance Control
- Supervisor
- Safety Officer
- Base Bioenvironmental Engineering Officer

5 TAGGING PROCEDURES. Indicators removed from engine will be tagged with an AFTO Form 350 and tracked with an AMARC Form 83. The AFTO Form 350 will be filled out IAW applicable regulations and will also have the oil level indicator serial number, engine serial number, and aircraft serial number listed.

6 CONTAINMENT. Removed indicators will be placed in an approved container and SE notified for pickup.

7 MARKING. Jet engines shipped with the source installed will be marked for radioactive material and shipped IAW applicable technical orders and federal regulations (10 and 49 CFR).

(3) FIREFIGHTING. Not combustible.

(4) LOCATION. This gas is used as part of an oil level indicating system in aircraft.

e. RADIUM. Used to mark signs, warning placards, circuit breakers, and instruments for emergency use in case of electrical failure. Radium provides a luminescent characteristic mixed with paints. It is a radioactive metal that emits alpha particles and energetic gamma radiation and causes the radium to be visible in darkness.

(1) HEALTH HAZARDS. While the radium particles are held together with paint, there is no health hazard. The health problems arise when the paint begins to chip and spill off which releases radium dust into the environment. Radium presents a twofold hazard, chemical and radiation.

(a) The chemical properties of radium present a health hazard only after entry into the body by inhalation, ingestion, or through an open wound. Inhalation is the most significant mode of entry. Radium deposits in bone as much as calcium.

(b) Radium provides both an internal and external radiation hazard. When taken into the body, the intense ionization produced by the alpha particles may cause severe localized damage to cells. Externally, the beta radiation causes skin exposure, the gamma radiation causes deep exposure. Given the limits, radium can constitute a serious external radiation hazard. The beta radiation exposure to the extremities can be reduced up 50% by wearing leather gloves. A few feet away, there is little radiation exposure.

(2) FIRST AID. Seek medical attention immediately.

(a) HANDLING PROCEDURES.

1 Skin contact should be avoided. Heavy gloves should be worn if handling is required. Deteriorated radium components should be wrapped and sealed in plastic bags or wrapping material. Bags should be marked for contents and radiation status. Lead can also be used to shield against the gamma radiation.

2 Industrial eye protection and approved respirators should be worn when removing or handling damaged or corroded radium components.

3 Materials used in handling deteriorated radium components (such as gloves or plastic wrap) will be placed in radioactive waste container for subsequent disposal IAW applicable guidance.

4 Personnel handling deteriorated radium should wash hands thoroughly with soap and water immediately after removal of gloves, before eating, drinking, smoking and at the end of the shift.

5 At no time will an attempt be made to remove the radium from a component with out specific approval from the USAF Radioisotope Committee, USAF OMS/ SGPR, Brooks AFB, TX.

(3) FIREFIGHTING. If material is on fire or involved in fire: contact the local, state, or department of energy radiological response team. Extinguish fire using agent suitable for type of surrounding fire. The material itself does not burn or burns with difficulty. Fizzles as radioactive material.

(4) LOCATION. Radium impregnated lacquers and paints may be found on a variety of aircraft and support equipment components.

f. STRONTIUM-90. Radioactive strontium isotope. Strontium-90 is a pale yellow soft metal.

(1) HEALTH HAZARDS. Strontium-90 is a high-energy beta material that is a highly toxic radioactive poison. Therefore, the hazard is both an internal and external radiation hazard. When taken into the body, the ionization produced by the beta particles may cause severe localized damage to cells. Attacks bone marrow with possibly fatal results. Externally, the beta radiation is classified as a skin exposure hazard only. Beta radiation exposure to the extremities can be reduced up to 10% by wearing leather gloves. At a distance of 30 feet, there is little radiation exposure.

(2) FIRST AID. Seek medical attention immediately.

(a) HANDLING INSTRUCTIONS.

1 No drilling, filing, machining, sanding, or other abrasive procedures are permitted.

2 Where prolonged body contact is possible or where abrasive operations are likely to affect the strontium alloy, the component should be removed and stored in a secure area.

3 Skin contact should be avoided. Heavy gloves should be worn if handling is required. Stronium-90 alloy metals with damaged plating will be wrapped and sealed in plastic bags or wrapping material. The plexiglas cap or suitable substitute will be installed on IBIS indications during all handling operations. Plastic goggles or glasses should also be worn when handling the IBIS indicators.

4 Industrial eye protection and approved respirator will be worn removing or handling damaged or corroded strontium alloys.

5 Materials used in handling corroded stronium-90 alloys (such as gloves or plastic wrap) will be placed in a radioactive waste container for subsequent disposal IAW applicable technical orders.

6 Personnel handling strontium alloys will wash hands thoroughly with soap and water immediately after removal of gloves, before eating, drinking, smoking, or at the end of the shift.

7 The AMARC Radiation Safety Officer will survey areas where corroded strontium-90 alloyed material has been handled or stored. Periodic surveys will be accomplished of all strontium storage or work areas.

8 Personnel handling or removing items containing strontium-90 from aircraft will wear a plastic face shield or goggles to protect the eyes from bremsstrahlung and or beta radiation.

(3) FIREFIGHTING. Fire or explosion, flammable / combustible material. May ignite on contact with air or moist air. May burn rapidly with flare-burning effect. Some react vigorously or explosively on contact with water. Some may decompose explosively when heated or involved in a fire. May re-ignite after fire is extinguished. Runoff may create fire or explosion hazard.

(4) LOCATION. Typically used in anti-ice detectors and blade integrity indicators for helicopters. Various aircraft.

g. THORIUM. A metallic element often alloyed with various metals to produce a strong lightweight aircraft component. Thorium is also found in the form of an optical coating on optical systems. See Appendix B for additional information.

(2) HEALTH HAZARD. Parts present no handling problems if appropriate precautions are followed. Thorium presents an internal and external radiation hazard. When taken into the body, the intense ionization produced by the alpha particles may cause severe localized damage to cells. Externally, the beta radiation is classified as a skin exposure hazard only. Beta radiation exposure to the extremities can be reduced up to 50% by wearing leather gloves. At a distance of a few feet, there is little radiation exposure.

(2) FIRST AID. Seek medical attention immediately.

(a) HANDLING INSTRUCTIONS.

1 No drilling, filing, machining, sanding or other abrasive procedures are permitted.

2 Where prolonged body contact is possible or where abrasive operations are likely to affect the thorium alloy, it should be removed and stored in a secure area.

3 Skin contact should be avoided. Heavy gloves should be worn if handling is required. Thorium alloy components with damaged surfaces should be wrapped and sealed in plastic bags or other wrapping material. Damaged components should be treated with caution and turned in as radiological waste.

4 Industrial eye protection and respiratory protection should be worn when removing or handling damaged or corroded thorium alloys.

5 Materials used in handling corroded thorium alloys (such as gloves or plastic wrap) should be placed in a radioactive waste container for subsequent disposal IAW applicable technical orders.

6 Personnel handling thorium alloys should wash hands thoroughly with soap and water immediately after glove removal, before eating, smoking, drinking and at the end of the work task.

7 The Radiation Safety Officer should survey areas where corroded thorium components have been handled or stored. Periodic surveys should be accomplished of all thorium component storage or work areas.

(3) FIREFIGHTING. Fire or explosion: Some of these materials may burn, but most do not ignite readily. Uranium and thorium granules may ignite spontaneously if exposed to air. Nitrates are oxidizers and may ignite other combustibles.

(4) LOCATION. Will occur when damaged or deformed parts are handled and fine dust fills the working environment. (The F-15 LANTIRN Pod is coated with a Thorium Dust.) The F-16 FLIR lens and mirror are coated with thorium fluoride 232. The sources are contained within two bolts within the unit; therefore, if the unit is destroyed personnel should avoid handling the bolts unless they are checked for radioactivity. Special handling is required for the lens and mirror.

h. TRITIUM. A radioactive isotope of hydrogen gas. Used as a luminescent material and can be found as a gas or impregnated paint compound.

(1) HEALTH HAZARD. Tritium is a low energy beta producing material. Therefore, the primary health hazard is ingestion into the body. The low energy significantly decreases the external radiation hazard.

(2) FIRST AID. Seek medical attention immediately.

(a) HANDLING PROCEDURES.

1 Wear gloves when handling items containing tritium.

2 If an item containing tritium should break while handling (such as an aircraft exit sign):

- Wash hands immediately
- Clear and control access to the area.
- Notify:
  - o Maintenance Control (MOC)
  - o Safety Officer
  - o Base and AMARC Radiation Safety Officer
  - o Supervisor
  - o Provide positive ventilation into the area

3 Wrap all components containing tritium in plastic prior to storage, supply turn-in or turn-in as radioactive waste.

(3) FIREFIGHTING. Severe, when exposed to heat or flame.

(4) LOCATION. Various aircraft.

2. COMPOSITE MATERIALS. To make a rapid assessment, the information is provided in a similar format found in 2000 Emergency Response Guidebook (ERG2000).

(1) HAZARDS. Mishap scenarios present different types of damage. Typical damages are structural or explosion with or without a fire or just fire damage.

- Two fire scenarios present different exposure concerns.

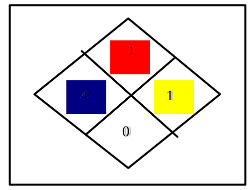
  o *Scenario one* is the early stage of a fuel-fed fire. With or without composite material a burning aircraft generates a large amount of soot and gases, many being toxic and potentially lethal. The addition of composite materials adds to the variety of lethal and toxic gases. Composite materials do contribute to the soot content of the plume but most of the soot will be due to burning fuel during a fire. Aviation fuel fires are exceedingly hot, >2000°F possible.

  o *Situation two* is when the fire is largely out and only a small amount of fumes and smoke is being generated with a large amount of debris scattered over a large area. Generation of lethal gases will drop rapidly with the decrease in flame temperature. Piles of burning composite debris could have deep-seated smoldering without producing visible smoke, light or intense heat. Smoldering smoke is toxic.

(a) HEALTH. Health concerns associated with burning plastics apply to burning composite material.

- Avoid skin contact with dust/particulate.
- Avoid inhaling airborne dust.
- Effects of smoldering inhalation may be delayed.
- Fire produces irritating, corrosive, and /or toxic gases.
- Impact and explosion damaged composites cause puncture wounds and the dust will cause skin irritations.

(b) FIRE. Using NFPA 704 M placard system, the following placard describes a generic composite part for a fire fighting response. **Health** describes the combustion or decomposition products generated in a large fire. **Flammability** rating can change from 1 to 2 depending on the type of coating. The **reactivity** rating of zero was given because the material is stable under normal fire conditions although it chemically changes, and will decompose under high temperatures. Reactivity reassessment is needed for hybrid composite systems and for the addition of the coating materials.



- A "composite system" is a combustible material because the matrix will ignite when heated. As the matrix burns volatile gases are released and char forms.
- Some resin types may melt and flow (polypropylene) and others just decompose (epoxy). The burning material may produce a popping noise.
- Depending on the fiber type, the fiber may or may not be combustible.
- Some composite systems may continue to burn when the fuel source has been removed.
- Imbedded metallic material may be found within the surface layers of the composite aircraft part.
- Individual lightweight fibrous layers can be thrown from the seat-of-the-fire.
- Boron coated fibers reacts exothermically with molten aluminum and other metals at high temperatures.
- Fires from a physically damaged carbon fiber composite can produce airborne carbon. If released during a fire, carbon fibers may linger for a time after the flame is out right at the burnt pieces.
- Avoid inhalation of burnt carbon fiber and dust when handling the debris.
- Enclosed areas increase exposures for smoldering gases and lingering fibers immediately following the fire.
- Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution.

(c) EQUIPMENT. Single carbon fibers and soot is electrostatic.

- Soot and single carbon fibers have the potential to cause electronic interference in **unprotected** circuits, and electrical connections (tests have shown that widespread equipment failure caused from airborne carbon fiber is highly unlikely).

- Plume exposure of equipment should be decontaminated before using.

- Carbon fiber fines (particulate) have abrasive qualities. If they have contaminated the lubrication or hydraulic systems, the systems will be at risk.

- Electrical conductivity of carbon fiber is not considered to be a direct personal health hazard.

(2) PUBLIC SAFETY.

- Dispersal pattern from the plume will depend on the wind. The plume will rise, become diluted and dissipate. Make upwind direction known and stay upwind with or without a fire condition.

- Airborne carbon fiber generation occurs *only for a very specific set of mishap conditions*. If there is a potential and the fire occurs in a populated area, advise to remain in doors, shut doors and windows, turn off forced air intake and wait for the plume to travel downwind.

- Keep unauthorized personnel away from debris. If a carbon fiber composite is severely shattered and burnt, isolate close-in (30 -160 feet) area in all directions immediately following the extinguishments of flaming and smoldering conditions to determine if fibers are lingering around the debris.

- Downwind fiber fallout area is dependent on a thermal column, wind speed and direction. Use mishap cordon size established for other immediate hazards like munitions or plume. Once the fibers fallout they will become integrated within the environment. Re-suspension of fibers is highest immediately after combustion conditions have ceased. Minimize movement of debris and soil.

(a) PROTECTIVE CLOTHING.

- Wear self-contained breathing apparatus when fighting composite fires and smoldering conditions. Full firefighting protective equipment will be worn for a flaming and smoldering combustion state. Structural gear provides only limited protection. If the fire fighter has to move in close to fight the fire, the protective clothing should be decontaminated of soot, combustion products and fiber as soon as possible.

(b) EVACUATION.

- Consider initial downwind evacuation for 2000 feet during plume generation. Keep non-essential personal out of immediate area. Need SCBA for smoldering conditions.

(3) EMERGENCY RESPONSE.

(a) FIRE.

- Composites can be a Class A or B fire depending on the matrix type. AFFF works best. Water will not completely extinguish deep-seated smoldering epoxy composites.

- A pool fire should be contained first, then concentrate on the burning composite. A fast response will reduce the chances that smoldering combustion occurs. Continuous and direct application of foam is needed for extinguishments of smoldering combustion with AFFF foam for at least three minutes.

- Expect a smoldering condition within a pile of severely shattered and burnt composite debris produced from a pool fire. A thorough overhaul inspection must be conducted to determine if deep-seated smoldering is occurring. Check for hot spots with infrared detectors.

(b) MATERIAL DISPERSION.

- Restrict the use of helicopter for *situation two*, fire is largely out and only a small amount of fumes and smoke is being generated with a large amount of debris scattered over a large are – restrict flying 500 feet above ground level, 1000 feet horizontally.

- Materials and particulate dispersion from damaged composites will occur right where the debris lies or along the path the tumbling debris took before it came to rest.

- Explosions will release more particulate at ground level than a fire release. Greater wind speeds reduce the plume raise. High wind speeds cause a low plume tilt. A low plume tilt could add to the ground level fallout concentrations.

(c) FIRST AID.

- Move victim to fresh air.

- Effects of inhalation exposure, or skin contact may be delayed. Ensure that medical personnel are aware of the materials involved and take precautions to protect them.

- Wash dust/particulate from skin with soap and water. Follow local medical protocols for airway, management as needed.

(d) SIZE-UP.

- A description of the composite debris is needed to determine the appropriate response level before transfer-of-command is made.

- After fire and smoldering conditions have ceased and the material is at ambient temperature walk around the debris and categorize the type of debris. Presence of carbon fiber clusters around the site is a sign that single carbon fiber may have been released. Communicate this information at transfer-of-command.

(e) TRANSFER-OF-COMMAND. Provide the following information for the hazards analysis sketch:

- type of composite debris
- downwind direction, wind speed
- plume condition
- if overhaul was needed

“Turn” to Appendix D for additional information about composites.

<u>3. RADAR ABSORBING MATERIAL AND CONVENTIONAL COATINGS</u>. Coatings are applied over composite surfaces. Coating thickness varies. RAM and conventional coatings are a polymeric based material. RAM coatings differ from conventional coatings by the addition of a radar absorbing material. The primary hazards associated with both coatings are the same. Because they are a polymeric based material the health hazard concern of coatings are not different than the composite matrix or resin, although the addition of the RAM may change the burning characteristics of the coating. Once the coatings are burned off, then the surface resin is affected.

(1) HAZARDS.

(a) FIRE AND EXPLOSION. Coatings are a combustible material. Ignition occurs by flame or heat. Some may burn more rapidly with flare burning effects. See 3.4(b) Composite Materials.

(b) HEALTH. Fire will produce toxic and irritating gases. Contact with fire debris may cause burns to skin and eyes. Runoff from fire control may cause pollution.

(2) PUBLIC SAFETY. See paragraph 3.4, composite materials.

(3) EMERGENCY RESPONSE. See paragraph 3.4, composite materials.

QUICK REFERENCE TABLES. Reference tables were created for the chemical, flammable and hazardous aerospace materials found within aircraft.

TABLE	TITLE	NUMBER TABLE PAGES
3.4-1	**Chemical/Radioactive Hazards Summary / Aircraft/Location**	**1**
3.4-2	**European Aircraft Hazards**	**3**
3.4-3	**Composite Systems Summary / DOD Aircraft**	**3**

Table 3.4-1 Chemical/Radioactive Hazards Summary / Aircraft/Location

CHEMICAL HAZARDS[1]	AIRCRAFT	LOCATION
Anhydrous ammonia	Obiter Vehicle	Aft Fuselage – 2 tanks
Anti-icing fluid	Various	Various
AFFF	N/A	N/A
Beryllium	A-7D, C-5, F-100	Landing gear bushings, brakes, wing tips
Ethylene glycol	Various	Liquid controls and calibrators
FC-77	E-3	Radar system coolant
Freon-502 Refrigerant	Various	Various
Halon	N/A	N/A
Hydraulic Fluid	Most	Various
Hydrazine	F-16, orbiter Vehicle	Top of the EPU
Hydrogen liquid	Orbiter Vehicle	Middle of fuselage – 2 tanks
Hypergolic Mixtures	Various	Various
Aviation Fuels	All	Assorted tanks and cells
Kapton® Film	Selected	Wire and cable insulator, radiation shield and insulation blanket
Lithium Thionyl Chloride	C-17	On-board mission computer batteries
Lubricating oils	All	Various
Magnesium	Most	Various wheel assemblies
Nitrogen Tetroxide	Orbiter Vehicle	Nose – 1 tank, Aft – 4 tanks
Oxygen – gaseous/liquid	All	Various
Quartz	B-1, B-2, F-15, F-117, F-22	Radome
PAA	Composite dust hold-down solution	Composite debris
Polyalphaolefin (Royco 602)	Various	Avionics, radar, radar countermeasure systems
Skydrol LD-4 and 5	Various	Hydraulic fuel line and reservoirs
Sulfurhexaflouride gas (SF-6)	E-3A	Lower lobe
Triethylborane (TEB)	SR-71	TEB bank mounted upper left side of engines
Tricresyl Phosphate (additive in Mobil Jet Fluid 254)	Various	Gas turbine engines of the turbo-jet fan, turboprop, turbo-shaft (helicopter)
[1] See Paragraph 3.3 for details		
RADIOACTIVE MATERIAL[2]	**AIRCRAFT**	**LOCATION**
Alloys	Various	Inlet transfer and rear gearbox
Americium-241	Various	FLIR
Depleted Uranium	A-10 C-5 C-130 C-140 C-141 F-16 H-3 DC/KC-10, L-1011, 747	30mm Ammo Ailerons, elevator Ailerons, elevator, rudder Rudder Ailerons, elevator Gun pods Control stick Ailerons, elevator, rudder
Krypton	Most	Oil level indication system
Radium	Various	In paints in warning signs
Strontium-90	Helicopters	Anti-ice detectors and blade integrity
Thorium	Various	Metal alloy, optical coating
Tritium	Various	Luminescent material as gas or in paint
[2] See Paragraph 3.4 for details		

Table 3.4.2 – European Aircraft Hazards (Table 1 of 3)

CODE	KNOWN HAZARD	FUNCTION	TOXICITY - INHALE	TOXICITY - SKIN	TOXICITY - AIR	DANGER	SUBSTANCE OR MATERIAL	EVAC
1	ACIDS – SULFURIC	Batteries	C	D			S1	E2
2	ACFT ASSISTED ESCAPE SYSTEM	Various Acft Types				D	S2	E1
3	ALKALINES (general)		C	D				E2
4	ARCTON 12							
5	ARCTON 112	Phosgen Gas When Heated						
6	ASBESTOS (dust/particles)	Insulation	C	A	B	A		E1
7	BERYLLIUM + BERYLLIUM OXIDES		C		D		M1	E1
8	BROMOCHLORODIFLUOROMETHANE	BCF Fire Extinguishant	B		C	A		E1
9	BROMOTRIFLUOROMETHANE	BTM Fire Extinguishant	B	A	C	A		E1
10	CADIUM (general)	Batteries/Bolt & Steel Protection	C		D	C	S1	E2
11	CARTRIDGE OPERATED EQUIPMENT	Non-Armament/PAD/CAD			A	D	S1	E1
12	CHLOROBROMOETHANE	Fire Extinguishant	C		C	A	M1	E1
13	COMPOSITE MATERIALS	Man-made Mineral Fibers (various acft)				D	S2	E2
14	COOLANOL							
15	CHAFF DISPENSER	Defensive Systems (various acft types)				D	S2	E2
16	DEPLETED URANIUM		D	C	D	D	M2	E2
17	DIMETHYLFORMAMIDE	Strobe Power Pack	B	C	C	C	M1	E1
18	EJECTOR RELEASE UNITS (ERU'S)	Various Acft Types					S2	E2
19	ETHYLENE GLYCOL		C	B	B	A	M1	E1
20	FLARE DISPENSER	Various Acft Types				E	S2	E2
21	FLUOROLASTOMERS	Burnt Seals						
22	FREON * (all types)	Air Conditioning/ Environmental Units	B	B	D Ozone depleting	A		E2

Cell 1 - Code: Hazard Code Number
Cell 2 - Known Hazard: Known Hazard
Cell 3 - Hazard Location
Cell 4 - Toxicity by inhalation
- A. Not considered toxic
- B. Low. Judged harmful only after massive exposure.
- C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
- D. High. May cause death or permanent injury.

Cell 5 – Skin toxicity. Destruction of skin tissue or absorption through skin into the system
- A. Not considered toxic
- B. Low. Judged harmful only after massive exposure.
- C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
- D. High. May cause death or permanent injury.

Cell 6 – Toxicity to atmosphere. Combustion products.
- A. Not considered toxic
- B. Low. Judged harmful only after massive exposure.
- C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
- D. High. May cause death or permanent injury.

Cell 7 – Danger rating from fire of material.
- A. No hazard.
- B. Slight.
- C. Moderate.
- D. Readily detonates when exposed to fire or shock

Cell 8. Substance or material.
- S1. Flammable or oxidizing substances.
- S2. Explosive substances.
- M1. Moderately or highly toxic materials.
- M2. Radioactive materials.
- M3. Water-reactive materials.
- M4. Cryogenic materials.

Cell 9 – Evacuation distance in all directions. Monitor wind conditions. Be prepared to relocate. Check points should be established up wind. Beware of smoke and/or vapor clouds.
- E1. 500feet/1,640.45 meters/200 paces
- E2. 1,000 feet/3,280.9 meters/400 paces
- E3. 1,500 feet/4,921.35 meters/600 paces
- E4. 2,500 feet/8,202.25 meters/1,000 paces
- E5. 5,000 feet/16,404.5 meters/2,000 paces

Table 3.4.2 European Aircraft Hazards (Table 2 of 3)

CODE	KNOWN HAZARD	FUNCTION	TOXICITY –INHALE	TOXICITY – SKIN	TOXICITY – AIR	DANGER	SUBSTANCE OR MATERIAL	EVAC
23	GROUND ILLUMINATING FLARE DISPENSER	Various Acft Types				D	S1	E2
24	ISOPROPYL NITRATE	"AVPIN"	C		C	E	S1	E2
25	LEAD (all types)		D	C	D	E	M1	E2
26	LITHIUM	Batteries					M3	E2
27	MERCURY (general)	Temperature Bulbs	D	D	D		M1	E1
28	METHYL BROMIDE	Fire Extinguishant	D	D	D	A	M1	E2
29	MINIATURE DETONATING CORD	Escape Systems/ Hatches/Canopies				E	S2	E2
30	NIEMONIC STEEL	Heat Shields	A	B	B	C		E1
31	NITESUN LIGHT SYSTEM							
32	POLYCHLORINATED BIPHENYLS	PCBs	C	C	D	A	M1	E1
33	POLYTETRAFLUOROETHYLENE	PTFE						
34	POTASSIUM HYDROXIDE		C	D	C	A	M1	E1
35	RADIOACTIVE SOURCES	DU, Thorium	C	D	D	A	M2	E1
36	SKYDROL HYDRAULIC OIL OX-20		A	B	A	A	S1	E2
37	SONAR LOCATOR BEACON(S)	Lithium Battery					M3	E2
38	STRONTIUM CHROMATES		B	B	C	A		E1
39	SULPHUR HEXEFLUORIDE SF-6		B	B	D	A		E1
40	THALLIUM (compounds)		C	C	D	A	S1	E1
41	THORIUM FLUORIDE		C	C	D	A	S1	E1
42	TRITIUM LIGHT SOURCES	Beta Lights	C		C	D	M2	E3
43	VERY FLARE							

Cell 1 - Hazard Code Number
Cell 2 - Known Hazard
Cell 3 - Function: Use or Location
Cell 4 - Toxicity by inhalation
A. Not considered toxic
B. Low. Judged harmful only after massive exposure.
C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
D. High. May cause death or permanent injury.

Cell 5 – Toxicity by skin. Destruction of skin tissue or absorption through skin into the system.
A. Not considered toxic
B. Low. Judged harmful only after massive exposure.
C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
D. High. May cause death or permanent injury.

Cell 6 – Toxicity to atmosphere. Combustion products.
A. Not considered toxic
B. Low. Judged harmful only after massive exposure.
C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
D. High. May cause death or permanent injury.

Cell 7 – Danger rating from fire of material.
A. No hazard.
B. Slight.
C. Moderate.
D. Readily detonates when exposed to fire or shock

Cell 8. Substance or material.
S1. Flammable or oxidizing substances.
S2. Explosive substances.
M1. Moderately or highly toxic materials.
M2. Radioactive materials.
M3. Water-reactive materials.
M4. Cryogenic materials.

Cell 9 – Evacuation distance in all directions. Monitor wind conditions. Be prepared to relocate. Check points should be established up wind. Beware of smoke and/or vapor clouds.
E1. 500feet/1,640.45 meters/200 paces
E2. 1,000 feet/3,280.9 meters/400 paces
E3. 1,500 feet/4,921.35 meters/600 paces
E4. 2,500 feet/8,202.25 meters/1,000 paces
E5. 5,000 feet/16,404.5 meters/2,000 paces

Table 3.4.2 European Aircraft Hazards (Table 3 of 3)

CODE	KNOWN HAZARD	FUNCTION	TOXICITY –INHALE	TOXICITY – SKIN	TOXICITY – AIR	DANGER	SUBSTANCE OR MATERIAL	EVAC
44	WATER METHANOL		B		B	D	S1	E2
45	WEAPON LOAD	If fitted, various acft types						
46	WINDSCREEN WASH FLUID AL-36							
47	ZINC SELENIDE	FLIR	C		C	A	M1	E1
48	HYDRAZINE H70	F-16, Orbiter, various acft types	D	D	D	C	M1	E2
45	WEAPON LOAD	If fitted, various acft types						
46	WINDSCREEN WASH FLUID AL-36							
47	ZINC SELENIDE	FLIR	C		C	A	M1	E1
48	HYDRAZINE H70	F-16, Orbiter, various acft types	D	D	D	C	M1	E2
49	HALON (gas and liquid)	Fire Extinguishant, Refrigerant	D	C	*	E	M4	E5
50	ISOPROPYL ALCOHOL		B	B	B	D	S1	E2
51	METHYLETHYLKETONE (MEK)	Cleaning Solvent	B	B	B	D	S1	E2
52	INSTRUMENT MIL 17808							
53	MOLYKOTE D32-1/R	Anti-icing Fluid						
54	AL-5	Windscreen Wash Fluid						
55	MERCURY CADIUM TELLURIDE (HgCdTe)	FLIR						

Cell 1 - Hazard Code Number
Cell 2 - Known Hazard
Cell 3 - Function: Use or Location
Cell 4 - Toxicity by inhalation

- A. Not considered toxic
- B. Low. Judged harmful only after massive exposure.
- C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
- D. High. May cause death or permanent injury.

Cell 5 – Toxicity by skin. Destruction of skin tissue or absorption through skin into the system.

- A. Not considered toxic
- B. Low. Judged harmful only after massive exposure.
- C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
- D. High. May cause death or permanent injury.

Cell 6 – Toxicity to atmosphere. Combustion products.

- A. Not considered toxic
- B. Low. Judged harmful only after massive exposure.
- C. Moderate. May cause illness or injury but not considered fatal except for unusual circumstances.
- D. High. May cause death or permanent injury.

Cell 7 – Danger rating from fire of material.

- A. No hazard.
- B. Slight.
- C. Moderate.
- D. Readily detonates when exposed to fire or shock

Cell 8. Substance or material.

- S1. Flammable or oxidizing substances.
- S2. Explosive substances.
- M1. Moderately or highly toxic materials.
- M2. Radioactive materials.
- M3. Water-reactive materials.
- M4. Cryogenic materials.

Cell 9 – Evacuation distance in all directions. Monitor wind conditions. Be prepared to relocate. Check points should be established up wind. Beware of smoke and/or vapor clouds.

- E1. 500feet/1,640.45 meters/200 paces
- E2. 1,000 feet/3,280.9 meters/400 paces
- E3. 1,500 feet/4,921.35 meters/600 paces
- E4. 2,500 feet/8,202.25 meters/1,000 paces
- E5. 5,000 feet/16,404.5 meters/2,000 paces

Cargo cabin insulation blanket produces phosgene gas on burning.

Note from the Editor:
HQ AFCESA/CEXF would like to thank Charles J. Baker and acknowledge his excellent effort in the HAZMAT arena. Permission wasgranted to use information from his book, *The Firefighter's handbook of hazardous materials, 5th Ed, 1990.*

Table 3.4-3. Composite Systems / USAF Aircraft (Table 1 of 3)

USAF	K/e	K/p	B/e	C/BMI	G/BMI	G/e	G/pami	G/pe	G/pimi	C/BMI	C/e	C/pimi	C/thpls	C/pbc	Q/bmi	Q/e	Q/pimi
A-10						X					X						
B-1		X	X			X					X			X	X	X	
B-2	X					X				X	X	X			X	X	
B-52						X											
C-5	X					X											
C-17	X					X					X	X					
C-32A	X										X						
C-37A	X					X					X						
C-38A	X										X						
C-130						X											
F-117	X				X	X	X		X	X			X	X			X
F-15			X			X		X						X	X		
F-16						X								X			
F-22				X	X					X		X	X	X	X		
OV			X								X						
SR-71																	X
T-1A	X																
T-4A						X											

Key for Composite Systems (fiber / matrix):

K/e = Kevlar / epoxy
K/p = Kevlar / phenolic
B/e = Boron / epoxy
C/bmi = carbon / bismaleimide
G/e = glass / epoxy
G/pami = glass / polyamide
G/pe = glass / polyester
G/pimi = glass / polyimide
C/e = carbon / epoxy
C/pimi = carbon / polyimide
C/thpis = carbon / thermoplastic
C/pbc = carbon / phenolic based carbon
Q/bmi = quartz / bismaleimide
Q/e = quartz / epoxy
Q/pimi = quartz / polyimide
G/bmi = glass / bismaleimide
C/bmi = carbon / bismaleimide

Table 3.4-3. Composite Systems / US NAVY Aircraft (Table 2 of 3)

US NAVY	K/e	K/p	B/e	C/BMI	G/BMI	G/e	G/pami	G/pe	G/pimi	C/BMI	C/e	C/pimi	C/thpls	C/pbc	Q/bmi	Q/e	Q/pimi
A-6						X					X						
AV-8B	X				X	X		X		X	X						
C-2						X											
E-2																	
E-2C						X										X	
E-6B																	
EA-6B					X						X				X		
F-14			X			X		X			X						
F/A-18	X					X		X			X						
H-53D,E						X											
P-3						X											
SH-60	X					X					X						
T-2						X											
T-34						X											
T-39						X											
T-44	X					X					X						X
T-45						X					X						
TH-57						X											
UC-12						X											
UH-1N						X											
V-22					X	X				X	X						

Key for Composite Systems (fiber / matrix):

K/e = Kevlar / epoxy
K/p = Kevlar / phenolic
B/e = Boron / epoxy
C/bmi = carbon / bismaleimide
G/e = glass / epoxy
G/pami = glass / polyamide
G/pe = glass / polyester
G/pimi = glass / polyimide
G/bmi = glass / bismaleimide
C/e = carbon / epoxy
C/pimi = carbon / polyimide
C/thpis = carbon / thermoplastic
C/pbc = carbon / phenolic based carbon
C/bmi = carbon / bismaleimide
Q/bmi = quartz / bismaleimide
Q/e = quartz / epoxy
Q/pimi = quartz / polyimide

Table 3.4-3 Composite Systems / US Army Aircraft (Table 3 of 3)

US ARMY	K/e	K/p	B/e	C/BMI	G/BMI	G/e	G/pami	G/pe	G/pimi	C/BMI	C/e	C/pimi	C/thpls	C/pbc	Q/bmi	Q/e	Q/pimi
AH-1	X					X					X					X	
AH-60	X					X					X						
AH-64	X					X					X						
CH-46						X					X						
CH-47	X					X					X						
CH-48																	
CH-53	X					X					X						
MH-53	X					X					X						
MH-60	X					X					X						
OH-58						X											
RAH-66	X										X						
RC-12	X					X					X						
UH-1						X											
UH-60	X					X					X						

Key for Composite Systems (fiber / matrix):

K/e = Kevlar / epoxy
K/p = Kevlar / phenolic
B/e = Boron / epoxy
C/bmi = carbon / bismaleimide

G/e = glass / epoxy
G/pami = glass / polyamide
G/pe = glass / polyester
G/pimi = glass / polyimide
G/bmi = glass / bismaleimide

C/e = carbon / epoxy
C/pimi = carbon / polyimide
C/thpis = carbon / thermoplastic
C/pbc = carbon / phenolic based carbon
C/bmi = carbon / bismaleimide

Q/bmi = quartz / bismaleimide
Q/e = quartz / epoxy
Q/pimi = quartz / polyimide

3.5 HAZARDOUS EVENTS.

The mishap site can be a dirty workplace. Sharp objects, such as metal shards, glass and precariously positioned debris is not uncommon. Holes or ditches, steep grades, uneven terrain, unstable surfaces can make it difficult to move about the workplace. To help assist site personnel to be on the look out for potential safety hazards, this section contains information for potentially lethal debris, hazardous materials that were generated under mishap conditions and hazardous situations to be aware of while working at the mishap scene. A description and instruction is provided that can be used to minimize safety and health hazards associates with events that lead to an unwanted situation.

a. BATTERIES. Alkaline or nickel-cadmium and lithium thionyl-chloride battery. Damaged battery detection can be a pungent odor due to venting. An overheat problem is detected by the presence of a short circuit and is hot to the touch.

(1) HEALTH HAZARD. Overheated batteries resulting from internal shorting or thermal runaway or mishap damage or abuse can cause rupturing or venting. It presents a hazard to personnel and aircraft through explosion and/or fire. Venting may be detected by discoloration of paint around the battery's vent. Thermal run-away may sound like popcorn popping. Gases released can be noxious or lethal. If the battery is damage or ejected into the mishap area, electrolyte solution can be spilled and fumes may be emitted. Ni-Cad electrolyte solution is potassium hydroxide (KOH). Lead based electrolyte solution is sulfuric acid. For a mishap or overheated cells wear rubber gloves, faceshields or goggles.

(2) FIRST AID. The electrolyte used in Ni-Cad battery is a strong alkaline solution. It is caustic and corrosive. Serious burns from contact with any part of the body. Treat burns as applicable.

(3) FIREFIGHTING. Shut off power before disconnecting the battery. Let it cool off. Open battery compartment and check for flame. For alkaline or nickel-cadmium battery fire, use Halon or CO_2. A lithium battery fire should be extinguished by a Class D fire extinguisher. Overheated batteries should be removed to the outdoors. Use water fog to reduce battery temperature. During fire use positive-pressure SCBA and eye protection.

(4) LOCATION. Batteries can be found in various locations.

b. BLOODBORNE INFECTIONS. Compliance with 29 CFR 1910.1030 is required for an aircraft mishap involving a potential exposure to bloodborne pathogens. Exposure can occur when rescuing victims, recovering deceased, handling human remains, handling investigative evidence, or during site cleanup. Contact with surfaces contaminated with blood and body fluids or a puncture from contaminated composite fibers are a threat. To reduce the emergency response risks the subsequent information was derived from, *Occupational Exposure to Bloodborne Pathogens Precautions for Emergency Responders, OHSA 3130.*

(1) HEALTH HAZARDS. Blood, bloody fluids, body fluids, and tissues are potential sources of bloodborne infections. Blood and body parts can easily contaminate equipment, and the immediate area of the mishap scene. Exposure can occur for any personnel who assist in the search and rescue response, the recovery of aircraft parts or components, safety investigation laboratory analysis, site clean up and disposal of contaminated aircraft parts. The route of exposure is through the skin via a cut or puncture wound; through mucous membranes (eye, nose, mouth); through broken skin, cut or abraded (dermatitis/rashes, injuries, abrasions).

(2) FIRST AID. Report any exposure to blood, body fluids or tissue to the mishap medical or health representative. Wash wounds and skin sites that have been in contact with blood or body fluids with soap and water; mucous membranes should be flushed with water; eyes should be rinsed. Wash exposed area with soap and water. Flush splashes to nose, mouth, or skin with water. Irrigate eyes with water or saline.

NOTE

If injury has occurred, team briefings should include information for safeguarding against the exposure. Contact the mishap medical or health representative. Treat all human blood and certain fluids as if they are infectious.

(3) PERSONNEL PROTECTION. An evaluation is made at the scene to determine how much protection is needed. The type and characteristics of the PPE will depend upon the task and degree of exposure anticipated. General safety measures are given below.

NOTE

Depending on the process that is occurring with and around composite debris, required protection for mishap composites may provide adequate protection against bloodborne pathogens.

NOTE

The minimum protection required for blood-borne pathogens will not provide adequate protection for a composite exposure. Surgical gloves will not protect against all puncture wounds. A surgical mask will not provide complete protection from airborne particulate or fibers.

(a) When infectious materials are present in the work area, a hazards warning sign with the biohazard symbol shall be posted at the access point.

(b) Wear powder free latex or nitrile gloves to protect the hands. Preferably long sleeve gloves. If other mishap hazards warrant leather gloves then wear the plastic glove underneath if soak-through is likely. Have extra pair of clothes available so torn gloves can be replaced immediately. Disposable clothes will not be washed or decontaminated for re-use if the integrity of the glove is not compromised. Decontaminate the leather gloves according to the clothing manufacture's instructions or use decontamination solution if it doesn't degrade the leather.

(c) Use eye protection (goggles, glasses with solid side shield or chin-length face shields) and mask to cover the nose and mouth to protect the skin of the face and the mucous membranes from splashes, sprays, spatters or droplets of infectious materials. Use protection in accordance with level of exposure encountered. An extra change of clothing should be available.

(d) Use disposal suits that are impervious to BBP to protect exposed skin.

NOTE

Tyvek suits will not completely protect against gross BBP contamination. Tyvek suit protects against a light liquid splash only. If conditions warrant sealed seams it must be specifically requested from the manufacturer.

(e) Hood and shoe covers or boots is needed when gross contamination is anticipated.

(f) Immediately after removing gloves or other protective clothing, wash hands with soap and water. If hand washing is not feasible, use antiseptic toilette and wash as soon as possible.

(g) Protective clothing must be removed and containerized at the location where used before leaving the area or upon contamination.

(h) Protective clothing must be placed in closeable, leak-proof container built to contain all contents during handling, storing, transporting or shipping and be appropriately labeled or color-coded.

(4) HANDLING CONTAMINATED COMPOSITES. If it is evident or suspected the debris is BBP contaminated, protection is mandatory. Handle in such a way as to not cross contaminate other surfaces. Minimize splattering and generation of droplets. Place contaminated pieces in an impervious plastic bag before placing in the appropriate transportation or shipping container. Double bagging is required if there are exposed fibers that could puncture the bag.

NOTE

Regulated waste found at a mishap site would be contaminated aircraft debris that would release blood or infectious materials in a liquid or semi-liquid state if compressed; items that are caked with dried blood or other potentially infectious materials are capable of releasing these materials during handling and the personal protective clothing.

(5) LABELING PROCEDURE. Contaminated pieces are bagged or wrapped in plastic and labeled as biological waste before the pieces are removed from the mishap site. Red bags or a red container may be substituted for a label. Labels shall state which portions are contaminated. Containers used to store, transport or ship infectious materials will have warning labels affixed to the container. If the storage or shipping container is labeled then the individual waste containers that are placed in the storage container does not have to be labeled.

(6) DECONTAMINATION OF EQUIPMENT OR WORK SURFACES. A solution of 5.25% sodium hypochlorite (household bleach) diluted between 1:10 to 1:100[2] with water is acceptable for cleaning. If decontamination of equipment is not done at the work site, the equipment is properly labeled before leaving the work site.

NOTE

Do not decontaminate laboratory samples. Make sure the laboratory sample has been properly identified for BBP.

c. <u>CONFINED SPACES</u>. Limited openings, restricted work areas and unfavorable natural ventilation can be caused by terrain, environmental conditions and crash conditions.

(1) HEALTH HAZARDS. The hazard is trapped air that will increase toxic air concentrations. Monitor the

[2] The Red Cross states, ¼ cup bleach to 1 gallon of water.

space for hazards conditions. Light the area as much as possible. Use appropriate PPE—such as an air purify respirator if airborne particulate is present or is going to be generated.

(2) FIRST AID. Provide fresh air.

NOTE

Respirator cartridge life will decrease for labor-intensive work (increases the breathing rate) and for increased localized airborne particulate concentrations.

d. COMPOSITE MATERIALS.

(1) SMOLDERING COMPOSITES, PLASTICS AND RUBBER.

(a) HAZARD. Some resin within a composite system can smolder. Some plastic and rubber material can smolder. Piles of burning composite materials may smolder. Smoldering composites produce toxic gases. Smoke is barely visible and does not radiate high temperatures.

(b) FIRST AID. Move victim to fresh air immediately. Isolate the immediate area and keep unauthorized personnel away. Stay upwind. If smoldering is noticed, alert the firefighting response.

(c) FIREFIGHTING. Extinguish with AFFF. Wear full firefighting protection with SCBA.

(d) LOCATION. Smoldering may exist for piles of composite debris that was burned in a pool fire.

(2) FUEL CONTAMINATED COMPOSITE MATERIAL.

(a) HAZARD. Cutting through composites that may contain residual aircraft fuels with a rescue-saw will cause sparking and possible ignition. Cool the blade with a fine water mist from a hose line while cutting. Use full firefighting protection. Spray area with AFFF to minimize potential of ignition.

(b) FIRST AID. Move victim to fresh air. For contact with burning substances, flush skin and eyes with water. Treat burns per local medical protocols. Isolate the immediate area and keep unauthorized personnel away. Stay upwind.

(c) FIREFIGHTING. The firefighting element will be in full protection including SCBA. Extinguish with AFFF.

e. HEAT STRESS. Heat stress can occur from wearing protective equipment any season and/or performing heavy work in hot, humid climate.

(1) HEALTH HAZARD. Heat stroke, heat exhaustion, heat cramps, transient heat fatigue and heat rash are the hazards of working in a hot environment.

(a) Heat stroke occurs when the body's temperature regulatory system fails. Symptoms for heat stroke are skin is hot, usually dry, red or spotted and body temperature is high, 104°F or higher. When body temperature increases the victim becomes mentally confused, delirious, and convulsions or unconsciousness could incur.

(b) Heat exhaustion is caused by the loss of large amounts of fluid or electrolytes. The worker suffering from heat exhaustion will experience extreme weakness or fatigue, giddiness, nausea, or headache and may be confused. The victim may vomit or lose consciousness. The skin is clammy and moist, the complexion is pale or flushed and the body temperature is normal or only slightly elevated.

(c) Heat cramps are painful muscle spasms that occur among those who seat profusely, drink large amounts of water and do not adequately replace the body's electrolyte loss. The cramps can occur during or after work.

(d) Heat rash or prickly heat can occur in hot, humid environments where sweat is not easily evaporated so the skin remains wet most of the time.

(2) FIRST AID.

(a) Immediate attention is needed to stop the effects of heat stroke. Treatment for heat stroke should concentrate on lowering the body temperature by removing or loosening tight clothing and soaking the clothing with water, removing the victim to a cool and shady area and fanning the head and upper body vigorously.

(b) Resting in a cool place and drinking plenty of water or liquids containing electrolytes is usually all that is needed for a heat exhaustion recovery.

(c) An electrolyte solution can relieve heat cramps or muscle spasms.

(d) Loose garments and good personal hygiene is the best prevention against heat rash.

(3) PRECAUTIONS. Work, using the buddy system. Watch out for each other. Be conscious of those around you. Pace yourself and take frequent breaks. The key to adapting to high temperatures is fluid intake—an 8-ounce glass every quarter-hour, a quart an hour, and two gallons during an 8-hour shift. There is know need to remove personnel protective clothing to rest just step

out of the immediate work area and stop working. Monitor body temperature. Don't hesitate to tell others how you feel.

f. HIGH PRESSURE SYSTEMS. The hydraulic system consists of a reservoir, pumps, accumulators and tubing that interconnects the system. The fluid is circulated and stored under pressure in the accumulator. Hydraulic fluid under pressure operates the landing gear, nose gear, steering, brakes and wing flaps.

(1) HAZARD. Cutting into pressurized hydraulic line will release the fluid in a fine mist that is toxic and flammable. If sprayed on hot surfaces the fluid may ignite. A hydraulic fire produces a torch effect, or if confined, the fuel vapors may explode. Broken composite debris will wick spilled hydraulic fluid.

(2) FIRST AID. See Skydrol.

(3) FIREFIGHTING. See Skydrol.

g. LIQUID OXYGEN OR LIQUID OXYGEN CONVERTER BOTTLES (LOX).

(1) HAZARDS. Liquid oxygen bottles may leak or vent when overheated, during impact, or when a seal ruptures. Liquid oxygen forms combustible and explosive mixtures and may react when in contact with flammable or combustible material like wood, cloth, paper, oil, or kerosene. Contact will cause frostbite. Gas is heavier than air and will collect and stay in low areas. Containers may explode when exposed to fire (BLEVE). LOX will increase the intensity of the fire.

(2) (5) FIRST AID. Provide basis life support as needed. Warm frostbite areas in very warm water. Stay upwind. Determine extent of problem. Isolate the area of release or fire and deny entry. Remove all ignition sources. Evacuate the area in all directions when LOX bottle is exposed to fire.

(3) FIREFIGHTING. Cut off the flow of liquid oxygen or fuel. Blanketing or smothering agents are ineffective. If flammable or combustibles are present, use large amounts of water at the seat of the fire, continue through to the source of the LOX leak and apply water until the ice forms and seals the leak. If water is not available, allow natural venting to occur with fire fighters at a safe distance with AFFF hoses in ready positions during the venting process. Fight fire with full protection and SCBA.

h. VITONÒ. Viton® is a trademark for a series of fluoroelastomers found in small quantities throughout the aircraft. In small quantities it poses as no threat to firefighting or for the initial response. Some aircraft contain large quantities. Runoff from fire control may cause pollution.

(1) HAZARD. Produces highly toxic combustion products like hydrogen fluoride, carbonyl fluoride, carbon monoxide and low molecular weight fluorocarbon fragments. Creates corrosive residue like hydrogen fluoride.

(2) FIRST AID. Remove victim exposed to fumes to fresh air at once and call a physician. Stay upwind. Ventilate closed spaces before entering.

(3) FIREFIGHTING. Extinguish with AFFF. Do not rinse burnt pieces with water or AFFF. It only contributes to the residue's corrosiveness. Full protective wear with SCBA. Neoprene clothes are needed to handle burnt pieces or residue.

(4) AIRCRAFT LOCATION. F/A-18, F-14D applied to engine exterior and other locations of the aircraft. Aircraft use gaskets and seals in small quantities.

i. TIRES.

(1) HAZARD. Tires present an explosion hazard when heated. An increase of air pressure occurs and can explode the tire. Rubber tires may ignite at about 500°F to 600°F and can develop extremely hot fires. Re-ignition may occur if the rubber sustains it auto-ignition temperature or the rubber is abraded and the fire is deep seated.

(2) FIRST AID. Remove to fresh air immediately. Seek medical attention. Stay upwind. Keep all unauthorized personnel out.

(3) FIREFIGHTING. Approach looking at the tire tread. Use Halon, AFFF or water fog as early as possible. Full firefighting protection with SCBA is required to work around smoldering tires.

(4) LOCATION. Inside landing gear door or scattered about the mishap site.

3.6 MISHAP RESPONSE PROCEDURES

Military aircraft may contain munitions that are an explosion hazard. Military aircraft may contain large amounts of fuel that is a flammable liquid hazard. Military aircraft may contain hazardous cargo. Military aircraft brake assemblies are a flammable solid hazard. Military aircraft contains small amounts of radioactive material. This paragraph contains information that can be used to prepare for a response and includes procedural information to consider when responding.

Safety and health procedures are written for the initial, follow-on and secondary response roles. Ultimately, the firefighting on-scene-commander will make the call as to what will be worn depending on the severity and type of fire condition during the initial response and the Bioenvironmental Engineer has the responsibility for health assessments made during the emergency response process. Information has been provided to assist with assessments during each phase of the mishap.

a. INITIAL RESPONSE.

(1) EN ROUTE. The initial and follow-on response must be alert to hazards when responding to a call.

(a) Determine the nature of the incident so the possibility of specific hazards can be determined. Ask the dispatcher if there were any unusual signs or symptoms, for example, pungent odors or eye irritations, the extent of fire, wind direction and velocity, location of the fire, color of the smoke, color of the flame.

(b) Pay attention to the sensory signals such as smell, color and nasal or eye irritations.

(c) Look for clues that suggest the possibility of hazardous materials like smoke or cloud of vapor.

(d) Pay attention to the wind direction and topography when approaching the site. Advance upwind and upgrade of suspected emissions.

(2) ARRIVAL.

(a) Avoid unnecessary contamination of equipment by giving exact information on safe routes of arrival and vehicle staging locations and by reporting anything suspicious.

(b) Do not drive through spilled or released material, including smoke, vapors and puddles.

(c) Unless otherwise directed, responders should park at a safe distance upwind, upgrade and pointing away from any incident where hazards are suspected. The firefighting response will determine the safest path to enter.

(d) Pay attention to low-lying areas such as streambeds and gulleys, or in urban areas places such as courtyards or near tall buildings. They may contain vapor clouds or the plume protected from dispersal by the wind.

(e) Anticipate a rush of people when in a populated area. Keep unauthorized people out. Use a PA system to give instructions if need be.

(f) Remember there are risks to entering a contaminated area to rescue an injured victim.

(g) Do not approach anyone coming from a contaminated area.

(h) Do not attempt to recover shipping papers or manifests unless adequately protected.

(i) Exclusion zones should be immediately established and enforced around the hazards taking care not to become exposed during the process.

(j) Advise population in the immediate downwind plume area of protective measures from the smoke plume.

1 Shut external doors and windows.

2 Turn off heating ventilation and air conditioning units.

4 Remain indoors until the plume has traveled down wind and dispersed.

5 Low-flying aircraft will be restricted from flying within 500 feet above ground level (AGL) and 1000 feet horizontally.

(k) Team briefs which includes the safety and health information are given during site orientation and before any processes are conducted at the site.

(3) DURING A FIRE.

(a) Initial response will establish cordon size for fire conditions such that cordon lies outside the smoke plume. All non-authorized, non-essential personnel will remain outside of the cordon. Restrict all unprotected personnel from assembling downwind of the site.

(b) Only firefighters wearing turnout (bunker) gear/ aluminized proximity suits and SCBA will be allowed into the area where an aircraft is on fire. Do not wear rubber gloves. Burning fuels, metal, plastics and composite materials are toxic. PPE for aircraft fires involving composites follows (structural firefighting gear may only provide limited protection):

Initial Response	PPE*
Fire, smoldering or cutting with a rescue saw.	Bunker gear or aluminized proximity suit, SCBA and aluminized.
***** OSC will make the final call.	

(c) Activation of the Personal Alert Safety System (PASS) is necessary when entering a hazardous area.

(d) Do not attempt to handle cylindrical objects, ejection seats, and anything that does not hamper firefighting action.

(e) Class B foam is most effective for fires involving composite material.

(f) Observe conditions that will help with the determination of the extent of damage: take notice of abnormal fire behavior of burning composite material (or any other material) like heat intensity, rate of flame spread, or unusual behavior when suppressant is applied. Information will be useful in understanding the behavior of the material and will help contribute to the evolving information needed to keep safe when fighting aircraft fires. Communicate unusual behavior to the composite materials technical representative or the Advanced Composites Office (AFRL/MLS-OL).

(4) POSTFIRE.

(a) If a pressurized container (and possibility buried munitions) is being heated by a deep-seated smoldering composite it can explode hours after the initial response has left the site. Move all pressurized bottles (LOX) and hydrazine containers away from burning and burnt debris piles, IF POSSIBLE.

(b) Due to the possibility of deep-seated smoldering of plastics and composite materials, post-fire does not begin until composite material is at ambient temperature.

(c) Immediately following flame suppression of a pool fire anticipate the underside of composite debris piles to be in a combustion state. The combustion state could be smoldering of the resin and core material or carbon fiber combustion. Resin smoldering can last for hours or days if not extinguished emitting faint smoke or heat that is only noticeable with a touch of the hand. Carbon fiber combust with a red glow and can last up to 1 hour after the flame has ceased (the pool fire is out). Temperature associated with the red glow is about 1400°F.

(d) Fixant can be applied once all site imminent hazards have been taken care of and the composite temperature is at ambient. Approval may be needed from the SIB before application begins. Composite spray team may need to be escorted if area is not clear of explosives hazards.

(e) Overhaul.

1 Perform overhaul to search for hidden fire. Overhaul is necessary if the mishap conditions produced confined spaces or closed-in working areas for the follow-on response. Overhaul is to be performed to determine if deep-seated smoldering is occurring.

2 A systematic approach is taken so the wreckage isn't disturbed beyond that which is necessary to conduct firefighting and rescue operations. Check for smoldering debris and extinguish it---tires, plastics and composite materials, metal. Self-contained breathing apparatus should always be worn when fighting a smoldering composite fire or performing an overhaul operation on composite debris.

3 Do not allow post-incident thoughts to interfere with the overhaul operation.

4 For investigation purposes, debris should not be moved more than what is necessary. If drastic movement of debris was necessary declare information at transfer of command.

5 Portable infrared heat detectors can be used to locate hot spots.

(f) Ensure no material is taken out of the area.

(g) Radioactive materials are used in small quantities. Radiation is invisible and some types of rays easily penetrate firefighter's protective clothing. Breathing apparatus may protect against one kind but not another. Protection is managed by limiting time around the source and maintaining distance from the source.

1 Radiation is measured by a survey meter or a Geiger counter. The dosage absorbed can be measured by a dosimeter. The Bioenvironmental Engineer will be equipped to detect and measure radiation.

(h) Attempt to control runoff without endangering personnel and equipment.

(5) SIZE-UP.

(a) Do not allow entry to any unauthorized personnel until the site has been adequately surveyed.

(b) Adequate protection from smoke is needed if EOD needs to enter an area of the site where there is a high potential of smoldering material.

(c) A combination of health and safety concerns can exist. The preliminary site evaluation will identify suspected conditions that are immediately dangerous to life or health or may cause serious harm. Approximate locations should be noted. The immediate concerns include the following:

- smoldering
- explosives
- electrical
- radiological
- toxic

(d) Once the immediate threats are controlled the following is noted.

1 Area affected by bloodborne pathogen contamination

2 Amount of environmental exposure from firefighting suppressant.

3 Type and amount of site damage

4 Local equipment damage

5 Exposed personnel

6 Include a gross assessment of composite debris, type and amount. Common terms are used to describe the debris:

- fragments
- delaminated layers
- strips
- clusters
- fiber bundles
- dust
- charred
- surface scorched
- coatings
- sandwich laminate

7 To determine if there is a potential for downwind carbon fiber fallout, take note of conditions that are likely to produce a carbon fiber fallout concern:

- dry climate
- large amount of unidirectional tape carbon fiber laminate that experienced impact then fire damage
- pool fire (standing or running fuel fires)
- high winds during the fire
- carbon fiber clusters strewn around the burnt debris and outside of the burn area
- single fibers collecting on plastics around the area, airborne fibers collected on plastic face piece
- by reflection, fibers seen floating in the air surrounding the burnt debris directly following the fire

(6) TRANSFER-OF-COMMAND.

(a) Recovery operations will not begin until all firefighting and rescue efforts are complete.

(b) A hazards analysis sketch of the scene should be drafted and be made available at site transfer of command.

(c) Information needed for the evaluation of composite damage and exposure concerns post-incident is:

1 Disclose fire conditions – pool fire, fireball, surface scorched only. Disclose plume direction and tilt behavior. Disclose main fuel source.

2 Disclose if there are carbon fiber clusters all around the burnt debris. Estimate the amount of debris.

3 If overhaul was performed disclose what was discovered.

4 Disclose if any smoldering material was left to burnout and its location. Mark the location on the hazards analysis sketch.

(7) DECONTAMINATION.

(a) Essential to minimizing secondary contamination, a deliberate decontamination process should exist for any amount of exposure and should occur at the site if possible.

(b) A gross wash down pool can be used to avoid secondary exposure from soot and composite dust on firefighting gear before leaving the site. A wipe-down with toilettes can be done if circumstances do not allow for a pool wash.

(c) Decontamination for bloodborne pathogen will follow NFPA Standard 1500 protocol.

(d) Firefighting equipment should be decontaminated at the site by water washing (preferred) or vacuumed depending on the contaminant.

(e) Soot and carbon fiber is electrostatic. If the aircraft was smoke plume exposed the following should be taken:

- Inspect air intakes and outlets for signs of smoke or debris and decontaminate as necessary. Vacuum the air intakes, pitot intakes and vents in wing.
- Internally ingested smoke, visually inspect all components for debris and vacuum thoroughly
- Prior to flying perform electrical checks and engine run-up.
- Significantly affected equipment - thoroughly clean antenna insulators, exposed transfer bushings, circuit breakers, etc.

b. FOLLOW-ON RESPONSE.

(1) PREPARATION/ARRIVAL.

(a) Be equipped to detect and measure radiation exposures.

(b) Consider having adequate firefighting equipment and personnel retained at the scene to combat latent fires.

(c) If smoke or smoke haze is seen, tasted or smelled retreat and contact firefighting response.

(d) Personal protection equipment (PPE).

1 The minimum level of protection needed for an aircraft mishap site is EPA Level D. The work uniform follows:

Situation	Protection
Peripheral areas	- Long sleeve, long-legged garment or BDU - Hard sole work shoes (steel toe and shank) - Eye protection - Gloves

2 Medical Response. If PPE is supplied at the mishap, a medical person may response without any. If supplied, it could be the standard "hazmat" garment. The standard "hazmat" garments are not what the medical community would use in a hospital setting. Standard medical wear for a cleanroom hospital environment will not protect from aircraft hazards and will not be durable enough for working among the wreckage. If stationed at a triage area away from the mishap site garment penetration or durability is not such an issue. Adequate protection for medical personnel will differ depending on where their response activities are performed. The following is considered:

- What are site hazards that medical personnel will come in contact with when working at the site?
- Will patient need to go through a gross decontamination before transporting to the support zone? What PPE is needed for the "decon" process?
- What will triage personnel be exposed to when patient is received?

3 Initial approach for bloodborne pathogen (BBP) assessment. BBP assessment is made at the scene to determine how much protection is needed before work processes begin. Personal protection guidance is given for the initial approach.

Situation	Protection
Site is suspected to have a bloodborne pathogen concern but there is no evidence of blood or tissue contamination.	Approach area of the site with: -gloves
Site had minimal injuries and limited evidence of blood or tissue.	Approach area of the site with: - gloves - disposable shoe covers
Site experienced gross contamination with blood and tissue.	Approach area of the site with: -gloves -shoe protection - full length garment - respiratory protection

4 Initial approach for composites assessment. Initial assessment of composite debris is made to determine the type of personal protection equipment needed before work processes begin. Guidance is given for the initial approach.

NOTE

Avoid excessive disturbance of immediate fallout area around the composite debris.

Situation	Protection
Physical damage only	Approach contaminated area of the site with: - long sleeve, pants, BDU - eye protection - long sleeves and pants, BDU - long-cuff gloves (no surgical gloves)
Explosion or high energy impact	Approach contaminated area of the site with: - long sleeve, pants, BDU - eye protection - long sleeves and pants, BDU - long-cuff gloves (no surgical gloves) - inhalation protection for disturbed dust and fibers
Fire damage only	Approach burnt debris with: - long sleeve and pants - long-cuff gloves - inhalation protection for nuisance vapor if inspection has to be performed in close proximity to the burnt debris.
Physical damaged and burnt composite	Approach contaminated area of the site with: - hard soles shoes - hooded garment - long-cuff gloves - eye protection - dual phase (organic/particulate[3]) air purifying respirator if inspection is performed in close proximity to burnt debris

(2) SITE ASSESSMENT.

(a) The DCG initial site assessment will verify safety information reported by the initial response element along with performing their individual assessment roles. A walk-through is conducted to identify sources of hazards to workers that will be performing mishap processes at the site. Information communicated to the OSC (most effective to communicate in writing, use hazards analysis sketch):

- sources of high temperature or sparks
- types of chemical exposure
- sources of harmful dust
- sources for radiation
- sources of sharp objects
- sources of rolling or pinching objects that can crush feet
- layout of workplace and location of workers
- electrical hazards
- obstructed vision sources

(b) Composite dust hold-down solution.

1 There are several different types of hold-down solutions. See paragraph 3.8 for solution type rationale.

2 Airborne debris will interfere with site work processes. To stop composite surface dust and fractured fiber ends from becoming airborne by wind or debris movement a temporary hold-down solution called fixant is applied to the damaged debris. Polyacrylic acid (PAA) such as floor wax has been used. Additional application can take place depending on the needs at the site.

NOTE

Fixant is a surface application only. It does not provide fiber stiffness. It does not penetrate composite layers. It does not prevent re-suspension of dust or broken fibers under or within the debris. It does not prevent the generation of new dust from handling the damaged debris.

3 Approval may be needed from the SIB before application begins.

4 Fixant application can be performed when the material has reached ambient temperature and after all site imminent hazards have been taken care of.

5 Ensure EOD has cleared area of explosive hazards. If not, the composite spray team may need to be escorted.

6 Fixant application instructions are found in secondary response procedures.

(c) Search and Rescue.

[3] Acid gas cartridge is meant for escape purposes only, not to work in. Retreat and contact firefighting response for an acid gas concern.

1. The systematic, detailed, laborious search and rescue process for remains needs to consider BBP exposure along with all the other potential hazards. Situational awareness includes the following: buried munitions, buried composite debris, buried metal debris, and buried aircraft/cargo fluids and AFFF. Search and rescue PPE considerations include BBP along with the buried hazard potentials.

2. The use of helicopters to visually survey the terrain and assist in determining the overall search area needs to consider the potential of re-suspending aircraft debris dust.

c. INTERIM SAFETY BOARD RESPONSE.

(1) Use hazards analysis sketch during site orientation.

(2) Conduct team brief before any work is done on site using the hazards analysis sketch and team brief checklist.

(3) The mishap site will be diagrammed for investigation purposes. Major components will be identified. Oil, fuel and hydraulic fluid will be collected. Constant situational awareness is required to limit any site exposures.

(4) Handling selected debris for investigative analysis.

(a) Wreckage involved in a safety investigation will be transported to a “safe-area”, as directed by the safety investigation board. The area should be not subjected to weather.

(b) Proper containment prior to transportation is required before transporting the investigation debris to a “safe-area”.

(c) Do not spray investigative debris with fixant.

(d) Composite wreckage will be wrapped in 0.006inch thick plastic and taped. Cover plastic with canvas to pad sharp fibers when needed.

(e) Tag and label (consider BBP contamination labeling concerns) all debris at the crash site prior to transporting to “safe-area”.

(f) Plastic attracts loose carbon fibers. Unwrap plastic at the “safe area” wearing gloves and a long sleeve garment. Burnt pieces will require protection from organic vapor. Air purifying respirator for particulate and organic vapor will be required for direct handling of burnt carbon fiber composites.

(g) If the “safe area” is a work environment for others consider that burnt debris will off-gas noxious odors.

d. SECONDARY RESPONSE.

(1) PREPARATION/ARRIVAL. The site has to be prepared for aircraft rescue and cleanup. Safety measures are taken to ensure the response operations go without incident.

(a) Use hazards analysis sketch during site orientation.

(b) Verify hazards assessment received from OSC then conduct hazards assessment based on operations that will be performed. Discuss assessment with OSC before operations begin.

(c) Factors that complicate operations at the site include:

- buried munitions
- buried remains
- composite fragments and fiber bundles buried around the bulk debris
- splashing of fuels/oils
- animals
- sharp metal edge debris
- environment and terrain conditions
- deep-seated smoldering composites (evacuate immediately)
- hot tires, brakes and batteries (evacuate immediately)
- ejection seat

(d) Determine the need for work, support and security zones.

(e) Prepare and conduct team brief before any work operations begin using team brief checklist and hazards analysis sketch.

(f) When appropriate, to eliminate the need to decontaminate equipment and tools by wrapping equipment and tools with plastic sheets that can be removed during the decontamination step.

(g) Include in the first aid kit an eye wash for composite dust and fibers, medication for localized burns from corrosive materials, tweezers for boron fiber puncture wounds (seek medical attention), hydrocortisone for minor skin rashes from composite dust exposure, antimicrobial skin wipes and heat stress monitor.

(h) Enforce the buddy system.

(i) Before moving damaged composite debris, use hold-down solution (fixant) to contain composite surface dust and fibers. Cover or wrap with canvas.

(j) PPE considerations for the secondary response processes are found in Table 3.7-1 at the end of this paragraph.

(2) FIXANT SPRAY OPERATION.

(a) Fixant application can be performed when the material has reached ambient temperature and after all site imminent hazards have been taken care of.

(b) Ensure EOD has cleared area of explosive hazards. If not, the composite spray team may need to be escorted.

(c) Three zones are established around the composite debris:

· Hot - the composite debris area
· Warm – PPE removal area and equipment "decon"
· Cold – clean area

(d) PAA fixant application has been applied using various types of sprayers. Small sprayers are chosen based on fluid capacity and handling capability. The backpack style seems to be most efficient.

(e) Fixant type is found in Table 3.3-7. The fixant is diluted not more than 10:1 with water. A recommendation for an F-16 mishap involving impact damage and fire is to take two five-gallon backpack sprayers for the initial spray and use the extra wax for subsequent treatments. As the wreckage is moved or recovered more application is required.

(f) Typically the composite spray team consists of 2 primary members with 2 backup members. Rotating teams may be necessary during high heat stress or cold exposure conditions.

(g) The work zone around the debris will be marked with traffic cone or barrier tape to secure against unauthorized entry before spraying begins.

(h) PPE will be donned before entering the spray area.

(i) The composite spray team briefing will discuss down wind direction, spray approach and site hazards associated with the operation.

(j) Spray all exposed surfaces, edges and particulate is sprayed. A slow sweeping action of the nozzle should be used. A blanket must be maintained over the entire surface, and broken edges.

(k) Fixant may have a pH that is a hazardous waste concern if it is excessively sprayed around the site contaminating the soil. Avoid over spraying the surrounding environment.

(l) For added protection, drape or wrap composite with plastic or canvas. If spraying is not possible, cover debris with plastic or canvas.

(m) After the initial fixant application minimize foot traffic around any composite debris.

(3) SPRAY TEAM DECONTAMINATION

(a) Decontamination of the composite spray team necessitates a process applicable to all mishap scenarios including remote locations (use process according to exposure encounter).

(b) The decontamination process will be conducted upwind of the hot zone.

(c) Place disposal containers for PPE and equipment drop in warm zone. Wipe dust and particulate collected on equipment with toilettes.

(d) To minimize creating wastewater, the roll-back decontamination method is preferred.

1 Hood is rolled back from face and turned inside out.

2 The zipper on the front of the suit is lowered and the suit is pulled off so the arms are turned inside out (the gloves were taped over the garments sleeves).

3 The suit is lowered while the contaminated person remains standing until only the boots remain in the suit.

4 Each leg is lifted and the suit is removed and placed in the dedicated disposal container. If the respirator is visibly dirty, clean while on the face with wipes.

5 While wearing the inner gloves remove respirator.

6 Remove cartridge.

7 Wipe inside and outside of respirator with wipes. HEPA vacuum can be used to remove debris from respirator face piece but wiping with toilettes will suffice.

8 Replace cartridge and dry in clean area.

9 Remove the inner glove and proceed to the clean area.

10 Wipe any skin-exposed areas with toilettes.

(4) AIRCRAFT RECOVERY.

(a) Hoisting an aircraft with a crane and sling, jacking and towing have specific safety hazards associated with each operation. Include a review of the hazards in the team brief (AFOSH STD and AFI91-216 for hoisting hazards).

(b) The ground crew involved with a helicopter aerial recovery operation is exposed to hazards of the noise, rotor downwash and electrical shock when contacting the helicopter cargo hook when it is positioned over a cargo hookup point. Include a review of the hazards in the team brief.

(c) Recovery operations will not begin until the OSC has released the aircraft to the Crash Damaged or Disabled Aircraft Recovery (CDDAR) team chief. Notify the OSC when the operation is commencing.

(d) Retain firefighting element if de-fueling is necessary.

(e) Prior to moving ensure the safety investigation board has all necessary cockpit switch and gage readings.

(f) All external stores and armament should be removed from the aircraft prior to performing any recovery operations. The removal of munitions may not always be possible due to the condition of the aircraft. A case-by-case evaluation is made.

(g) Verify components of canopy jettison and seat ejection system has been “safed” or disarmed prior to performing recovery operations.

(h) Verify all electrical systems are de-energized.

(i) Disconnect battery prior to recovery operations. Remove the battery from the aircraft if there was any spillage or damage.

(j) Obtain weather information prior to lifting. Conditions may interfere with cranes, tow vehicles, or helicopter use and crash trailer placement at the site.

(k) Use absorbent pads as soon as possible to soak up spilled fuels when performing the recovery operation. Avoid any operation that will sharp or ignite the spill.

(l) Identify downwind direction especially when working around liquid spills and burnt carbon fiber composite debris.

(m) Contain damaged composites with fixant and canvas before aircraft recovery operations begin following instructions found in subparagraph 3.6.c.4.

(n) Before removing aircraft wreckage perform a dry run with the equipment and technique.

(o) Team chief monitor operations and evaluate the effectiveness of the plan.

(p) Aerial recovery of aircraft will disperse loose dust or debris. A soil tackifier spray will help keep the dust from becoming airborne.

(5) BASICS FOR CUTTING MISHAP-COMPOSITE MATERIALS.

(a) Do not bend or flex fibers over a small radius. Do not run hands along the end of the laminate or fracture surfaces.

(a) Ordinary shears will not successfully cut most composite materials.

(b) A razor or utility knife is fine for cutting a small number of layers. Use a template to help guide the blade. To prevent injury, wear leather or Kevlar® glove on the non-cutting hand.

(c) An abrasive cut-off wheel blade will work for most mishap-composites. The manufacturer for Kelvar® fibers recommends a carbide tipped blade with an alternating tooth angle.

(d) Cutting with a circular saw creates resin dust and particulate, single fibers and fiber bundles ranging in size. Cutting Kevlar® creates fibrils. Cutting composites with carbon, boron, glass or quartz will create single fibers ranging in length and some of the single fibers will be longitudinally split. Dual-phase respiratory protection is required.

(e) A high-speed saw will heat the resin and produce nuisance-level organic vapor. The resin may become tacky and gum-up the edge of the blade.

(f) Backing the piece with aluminum, wood or cardboard before cutting will improve the cutting quality (quality may be necessary for an investigative piece).

(g) Composites are made of layers of material. Consider the presence of a metal layer within the laminate or on the backside when cutting completely through the piece.

(h) Consider tools used for the repair of composites to cut small sections of composite for investigation purposes.

(i) Damaged composite material can absorb liquids. Damaged composite may contain fuel residue or other combustible liquid residue. Cutting composites with a rescue saw creates a lot of airborne debris and noxious vapor. The cutting operation should be water cooled when possible. Foam should blanket the working area if there is a potentially high risk of sparking residual fuel.

(6) MISHAP DEBRIS CONTAINMENT.

(a) Debris that will be scrapped requires a sorting process and proper composite containment before transporting off-site. Systematically separate and box the debris. Composite material is separated from non-composite and containerize. Container needs:

1 Large bulk pieces: wood box with a cover (cardboard will not provide containment throughout the lifecycle of the wreckage).

2 Small size pieces: five or ten-gallon plastic buckets with closeable lids.

3 Labeled tags:

COMPOSITE DEBRIS

Aircraft MSD ______________________
Content ______________________
Fixant Type ______________________
Spray Purpose ______________________

WARNING

Combustible solid. Use Class B extinguishment. Dust is and eye, skin and inhalation irritation. Fibers cause puncture wounds. Burnt debris has an unpleasant odor. Do not incinerate, do not sell for scrap. Dispose if in approved landfill.

(b) Indoor storage. Burnt and/or damaged bulk composite pieces are sprayed with fixant and wrapped before containerizing.

.

1 Follow fixant spraying operation in subparagraph 3.6.c.2

2 Wrap large bulk pieces with plastic and/or canvas and tape.

(c) Outdoor storage. Plastic wrap and tape is not suitable for outdoor storage. PAA fixant is not a permanent hold-down solution. Sharp edges tear the plastic exposing the debris and the tape degrades. Canvas wrapped plastic can provide additional. The following is required if the composite debris cannot be containerized.

1 Contain fibers with a permanent fixant solution. Corrosion preventative compound (CPC), MIL-C-16173 Grade 4 spray has been tested for environmental exposure.

2 If CPC is not available then use PAA fixant.

3 Wrap and tape with 0.006-inch plastic and/or canvas.

4 Tag and label, see .3.6.c.4.3.

(7) SITE CLEANUP.

(a) Work practice:

1 Do not dry sweep. It puts dust in the air.

2 Use water or a vacuum system with a HEPA filter for cleaning surfaces and equipment.

3 Compressed air is not for cleaning clothes or equipment.

4 Work upwind of dust clouds or dusty areas when possible.

5 Report any skin and breathing irritations, cuts or rashes.

NOTE

When in Tyvek suit under high heat conditions, rashes developing from heat stress or prickly heat can be misconstrued to be a rash development from composite exposures.

6 No smoking, drinking or eating.

7 Shower with warm water as soon as possible after working with severely damaged composites, contact with burnt debris and liquid spills.

8 Use hand signals for line-of-sight communication.

(b) Composite handling at the site is a localized concern. Exposure issues are right at the damaged pieces. Identify work area when clearing site of composite debris piles. A work zone of not more than 25 feet can be appropriate for handling quantities of damaged composites, weather dependent. Work zone is realistic to the handling process, environment and weather conditions.

CAUTION
CONTAINS COMPOSITE DUST AND FIBERS
Avoid creating dust
Do not enter work area without proper protection

(c) Moving composite debris around with a backhoe or forklift will generate loose composite dust and fibers. Avoid flying fragments and spread of debris when moving piles of debris. Spray fixant solution on bulk composite debris before movement begins.

(d) Direct contact when moving piles of loose composite debris requires full respiratory, eye and skin protection.

(e) If the conditions at the site are going to re-suspense airborne particulate during cleanup a tackifer spray can be used to adhere loose particulates to the soil.

(f) Collect the debris and containerize in an organized fashion. The debris can be sorted by system and material type.

(g) Cleanup randomly scattered composite small fragments, strips, clusters, core material, and foam by placing in to labeled plastic buckets.

(h) Large bulk pieces are placed into wood boxes.

(i) Bloodborne contaminated pieces will be boxed separately and properly labeled, see subparagraph 3.5.b.

(j) Remove loose contaminate such as composite dust composite from hard surfaces like concrete by vacuuming or a water/detergent wash.

(k) Soot removal from solid surfaces will require washing with a high alkaline cleaner.

(l) Aircraft fuel and liquids, fire suppressant, and hydrazine contamination will cause an environmental site assessment. The final cleanup process will be determined by the environmental assessment.

(m) Equipment decontamination method will depend on type of contaminate:

1 Loose contaminates like dust or particulate: HEPA vacuum or water/detergent wash.

2 Aircraft liquids: chemical rinses or high pressure rinses with or without heat.

3 Adhering contaminates like resin char or tacky plastic materials: scrapping and brushing with a chemical rinse.

4 electrostatic attached particles: spray or clean equipment before use with antistatic solutions (spray needs to be fire resistant).

(n) Wastewater should be collected and disposed of properly. A number of methods have been used for collection: trench, pool or tarp. The means of disposal will be determined by the water contaminate and concentration.

(8) TRANSPORTING DEBRIS OFF-SITE.

(a) All debris will be adequately contained as described before transporting off site.

1 Buckets are sealed with a lid.

2 Debris is in a wood box covered with a lid or contained within canvas.

QUICK REFERENCE TABLES. The following tables detail information to consider when making a PPE assessment for composite operations during the secondary role response. The information clarifies possible exposures for a specific response process.

TABLE	TITLE	NUMBER OF TABLE PAGES
Table 3.6-1	**Rapid Response Checklist**	**3**
Table 3.6-2	**SECONDARY RESPONSE - PPE Considerations**	**4**
Table 3.6-3	**Composite Handling Work Process Survey**	**1**

Table 3.6-1. Rapid Response Checklist
Initial Response (Table 1 of 3)

Advance upwind, upgrade of emissions.	
Direct follow-on to park upwind, upgrade.	
Control rush of people; secure area immediately with a clear chain-of-command.	
Ensure no debris is taken off site.	
Enforce exclusion zones immediately and monitor ECP.	
Advise populace in the downwind plume area of protective measures.	
Restrict low flying aircraft to 500ftAGL, 1000ft horizontally as needed.	
Activate PASS when entering unknown or hazardous situation.	
Size up situation and continually size up throughout the incident.	
Identify aircraft, passengers and cargo.	
Only firefighting wearing turnout gear / aluminized proximity suits, SCBA into area where aircraft is on fire.	
Use Class B foam extinguishment for composite fires.	
Avoid high-pressure straight streams directed at the burning composite.	
Control run-off.	
Record unusual fire behavior.	
Move gas tanks, bottle away from burning debris.	
Don’t handle ejection seats if possible.	
Advise dispatcher of unusual signs, extent of fire, wind direction/velocity, plume direction, spread of ash/airborne composite debris, amount of composites and extent of damage.	
Post fire doesn’t begin until material is at ambient and overhaul is complete.	
Extinguish fire and smoldering materials and cool to ambient.	
Check for deep-seated smoldering in large piles of burnt composite debris.	
Use infrared detection for overhaul.	
Do not allow entry until site has been adequately surveyed.	
Enforce isolation zone (30-80ft) immediately following a flaming combustion state involving a pool fire and large amounts of carbon fiber composite debris. Enforce zone until it has been determined if there are lingering carbon fibers around the burnt, or smoldering debris. If so, enforce zone until fibers fall-out.	
Take note of conditions that may lead to a downwind carbon fiber fallout potential and inform dispatcher and at T-O-C.	
Conduct Size-up using hazards checklist and sketch.	
Minimize activity around shattered debris, especially for shattered composite debris.	
Include a description of composite debris on hazards sketch.	
Fixant can be applied to composite debris once all the imminent hazards are taken care of and the material is at ambient temperature.	
Escort spray team if area is not clear of hazards (munitions).	
Establish decontamination area for initial, follow-on and secondary response when needed.	
Perform gross plume decontamination at the site.	
Decontaminate equipment at the site.	
Recovery operations will not begin until all firefighting and rescue operations are complete.	
At transfer of command, supply the hazards sketch during safety de-briefing.	

Table. 3.6-1 Rapid Response Checklist
Follow-On Response (Table 2 of 3)

Retain firefighting at the scene to combat latent fires.	
Be equipped to detect and measure radiation.	
Retreat if smoke, smoke haze is seen, tasted or smelled.	
No eating, drinking or smoking on site.	
Establish clean and dirty areas of the site.	
Use protection guidance given for the initial approach to a contaminated area of the site.	
Enforce minimum level of protection for all responders until a process assessment is made to determine what additional protection is warranted.	
Thorough walk-through will include verification of information reported by the initial response element using the hazards sketch or checklist.	
PPE “Rules-of- Thumb” is mishap-process dependent. Understand what the process is and what the potential exposures are when making a PPE selection.	
If composites are present advise OSC, by radio with amount, and extent of damage.	
Get SIB approval before applying hold-down solution to the composite debris.	
Use soil tackifer if needed.	
Search and Rescue considers re-suspension potential of debris if helicopter is going to assist effort.	
Use hazards analysis sketch during site orientation.	
Conduct team brief using checklist before any process begins.	
Investigative samples will be prepared for transporting to “safe area”.	
Hold-down solution (fixant) will not be sprayed on investigative samples.	
ECP will be continually monitored.	
Removed contaminated clothing immediately.	
Advise medical representative of any symptoms during response and post response.	
Retreat and advise OSC of any unsafe situations immediately.	

Table 3.6-1. Rapid Response Checklist
Secondary Response (Table 3 of 3)

Site has to be prepared for aircraft rescue and cleanup.	
Use hazards analysis sketch/checklist during site orientation and team briefs.	
Verify hazards assessment received from OSC then conduct assessment based on operation that will be performed.	
Enforce the buddy system.	
Before moving composite debris, spray with fixant or cover or wrap with canvas.	
PPE "Rules-of- Thumb" is mishap-process dependent. Understand what the process is and what the potential exposures are when making a PPE selection.	
Fixant can be applied to composite only when the debris has reached ambient temperature.	
Minimize foot traffic around scattered debris	
Use work zones (25ft) when handling composite debris.	
Review aircraft recovery hazards before moving CDDAC.	
Retain firefighting if de-fueling is necessary.	
Retain firefighting if cutting operations could ignite residual fuels.	
Work upwind of any hazard and severely shattered composite debris.	
Avoid spread of composite debris when moving piles around with backhoe or forklift.	
Use soil tackifer if operations will disturb surface debris particulate or dust.	
Sort debris before transporting off-site	
Use adequate shipping containers with closeable lids.	
Containers will be properly labeled and sealed before transporting off-site.	
Use adequate containment procedures for indoor storage, especially for burnt debris.	
Do not sweep during site cleanup. Use HEPA filter vacuum on hard surfaces. Do not use compressed air for cleaning. Work upwind.	

Table 3.6-2 Secondary Response - PPE Considerations (Table 1 of 4)

Operation	Protection Consideration		Equipment
Cleanup of randomly scattered small size composite debris: fragments, strips, clusters, and pieces of sandwich structures, foam. Handling of small pieces scattered over a large area does not generate an appreciable amount of airborne particulate.	**Eye and Face**	Loose fibers protruding from the debris.	Goggles
	Respiratory	-	-
	Head	-	-
	Foot	Puncture from sharp objects. Fluid spills. Harsh terrain.	Hard sole work shoes.
	Hand/ Forearm	Puncture wounds from protruding fibers. Residual dust, char material or spilled fluids.	Inner long-cuffed nitrile glove. Outer leather glove.
	Body	Dirty and/or harsh environment.	Long sleeve BDU or TYVEK suit.

NOTE

Other operations, occurring at the same time, site conditions and weather may require additional protection.

Table 3.6-2. Secondary Response - PPE Considerations (Table 2of 4)

Operation	Protection Consideration		Equipment
Backhoe, forklift or shoveling of damage/burnt composite debris. Handling piles of damaged composites can produce appreciable amounts of airborne particulate, WITH OR WITHOUT FIXANT. Requirement is for direct contact with the debris. Requirement is for anyone within the work zone when piles of composite debris are being moved.	**Eye and Face**	Airborne composite dust, and fibers of various sizes.	Goggles with half-face respirator or full-face respirator.
	Respiratory	Airborne composite dust, fibers, and fiber bundles.	Full-face respirator preferred: combination filter (organic vapor and particulate 99% efficiency) for burnt debris and particulate for physically damaged debris.
	Head	Flying debris.	Hardhat.
	Foot	Puncture wounds from sharp objects, impact from carrying objects that can fall on the feet, fiber bundles.	Hard sole and toe working shoes.
	Hand/ Forearm	Puncture wounds, residual dust, char material or spilled fluids.	Inner long-cuff nitrile glove. Outer leather glove.
	Body	Generation of airborne composite dust, fibers, char material. Puncture wounds from fibers.	Hooded TYVEK suit with elastic wrist and ankles. Booties are optional

Table 3.6-2. Secondary Response - PPE Considerations (Table 3 of 4)

Operation	Protection Consideration		Equipment
Cutting the composite (undamaged or damaged) with a rescue saw, pounding, or drilling. Cutting with a saw will generate heat, airborne particulate and organic vapor, WITH OR WITHOUT FIXANT. Requirement is for the team in direct contact with the debris and anyone within close proximity. **NOTE** Other operations, occurring at the same time, site conditions and weather may require additional protection.	**Eye and Face**	Airborne dust, fibers and fiber bundles.	Goggles with half-face respirator.
	Respiratory	Airborne composite dust, fibers and fiber bundles.	Full-face respirator preferred: combination filter organic vapor and particulate 99% efficiency. R series filter is needed when lubricates or cutting fluids are used.
	Head	Fibrous particulate	Tyvek hood, see body
	Foot	Puncture from sharp objects and fiber bundles	Hard sole and toe working shoes
	Hand/Forearm	Puncture wounds, residual dust, char material or spilled fluids.	Inner long-cuff nitrile glove. Outer leather glove
	Body	Generation of airborne particulate, fibers, char material. Puncture wounds from fibers.	Hooded TYVEK suit with elastic wrist and ankles. Cutting with a saw may cause sparking. Sparks will destroy the Tvyek suit. An outer covering like rubber apron or leather chaps can be used to protect against sparks. Booties are optional.

Table 3.6-2 Secondary Response – PPE Considerations (Table 4 of 4)

Operation	Protection Consideration	Equipment	Protection Consideration
Composite Spray Team The two-member spray team is walking around the debris in very close proximity. The sprayer doesn't have direct contact with the debris. To get adequate coverage, the second team member may slowly lift layers of debris slightly.	**Eye and Face**	Airborne dust and fiber bundles.	Goggles with half-face respirator.
	Respiratory	Airborne dust and fibers and fiber bundles.	Air-purifying respirator: Filter for dry particulate 99% efficiency. If the debris is burnt use a dual phase filter, include an organic vapor phase.
	Head	-	Tyvek hood, see body.
NOTE Use PPE according to site conditions and processes preformed.	**Foot**	Punctures from harp objects, fiber bundles	Hard sole and toe working shoes.
	Hand/Forearm	Puncture wounds from fiber bundles, ash, soot, composite dust	Direct contact with debris requires an inner and outer glove. Puncture resistant outer glove with a dust and PAA resistant long-cuffed inner glove. The inner glove is pulled over the sleeve and taped. No debris contact requires a dust and PAA resistant glove.
	Body		Hooded TYVEK suit with elastic wrist and ankles. Duct tape to seal the top of the Tyvek suit zipper Booties are optional.

Table 3.6-3 Composite Handling Work Process Survey

Activity	Debris Information[4]	Work Conditions	PPE
Physical Damage			
Fire			
Smoldering			
Overhaul			
Explosion			
Walking to the Site			
Visual inspection with hand movement			
Cutting, prying, sawing, pounding, lifting with backhoe			
Search and Rescue			
Site Clean-up Picking pieces from topsoil Dissembling pieces Sorting Preparing for Transport Off site Excavating Digging Sweeping			
Preparing for Transportation Spraying, wrapping, container			
Transportation (Truck, flat bed…)			
Storage (short term, long term)			
Disposal Open storage boxes Sorting Cutting			

WORK SHEET

[4] Debris Information = type and amount of debris, condition of debris, location of debris.

3.7 TABLES AND RESPONSE WORKSHEETS

A number of tables, checklists or worksheets have been developed to help prepare for and to assist with the communication process during a response.

TABLE	TITLE	NUMBER OF TABLE PAGES
Table 3.7-1	**Initial Isolation Zones**	**1**
Table 3.7-2	**Minimum Withdrawal Distances for Explosives Involved In Fire 1, 4 and 5 (Ref. T.O. 11A-1-46)**	**1**
Table 3.7-3	**Aircraft Mishap Hazards Assessment**	**2**
Table 3.7-4	**Mishap Team Brief Topics**	**2**
Table 3.7-5	**Hazards Analysis Sketch**	**2**
Table 3.7-6	**Composite Assessment Questions**	**1**
Table 3.7-7	**Composite Particulate Hold-Down Solutions**	**1**
Flowchart 3.7-8	**Site Hazard / Fixant Application**	**1**
Table 3.7-9	**Emergency Response Equipment, Apparel and Supplies**	**1**
Table 3.7-10	**Major Aircraft Terminology Used At Crash Sites**	**1**

Table 3.7-1. Initial Isolation Zones

SCENARIO	INITIAL ISOLATION ZONE[5]	RESOURCE
Initial approach for a small JP8 spill	80-160ft in all directions	Emergency Response Guidebook for a kerosene response.[6]
Initial approach for a large JP8 spill	1000ft downwind	Emergency Response Guidebook for a kerosene response.[2]
JP8 fire	½ mile in all directions	Emergency Response Guidebook for a kerosene response.[2]
Weapons	1000ft	AFI
Any fires burning in wreckage where HAZMAT is present	2000ft upwind	AFPAM 91-211
Unknown substances	4000ft	AFI
B2 mishap	5000ft	Whiteman Oplan 32-1
Helicopter approach for conditions: • Hazardous material spill • Smoldering composite debris • Piles of burnt and/or shattered composite debris	500 feet above ground level 1000 feet horizontally	AFI 32 Series
Burnt composite debris immediately following the extinguishment of pool fire or smoldering	30-80ft in all directions	Emergency Response Guidebook for an initial approach for an asbestos spill [2]
Burnt or broken composite debris piles - work zone	Not more than 25ft	Composite Aircraft Mishap Safety and Health Guidelines[7]

[5] The on-scene-commander will determine necessary cordon distances.
[6] U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A guidebook for First Responders During the Initial Phase of a Hazardous Materials/Dangerous Goods Incident.
[7] Air Standardization Coordinating Committee, Advisory Publication 25/41

Table 3.7-2. Minimum Withdrawal Distances
For Explosives Involved In Fire 1, 4 and 5 (Ref. T.O. 11A-1-46)

CLASS/ DIVISION			DISTANCE (feet)					
			300	**600**	**2500**	**4000**	**5000**	**K105**
1.4	Minimum Distance		X					
1.3	Minimum Distance (See Note 2)			X				
1.2 / 1.6	Minimum Distance				X			
1.1 and 1.5	Unknown Quantity	Aircraft, Truck, Tractor, Trailer, Facility				X		
		Railcar					X	
	Transportation	500 pounds or less, all modes			X			
		More than 500 pounds, railcar					X	
		More than 500 pounds, all other modes including aircraft				X		
		All quantities bombs and explosives greater than 5-inch caliber				X		
	Facilities	15,000 pounds or less			X			
		More than 15,000 pounds, less than 50,000 pounds				X		
		More than 50,000 pounds						X

ESSENTIAL PERSONNEL (SEE NOTE 3).
ACCIDENTS INVOLVING EXPLOSIVES WITHOUT FIRE (SEE NOTE 6).

NOTES:

1. For Class/Division 1.1 and 1.2 munitions, use maximum debris and fragment throw ranges, if known, in lieu of distances in this chart.

2. For quantities of 1.3 over 100,000 pounds, withdrawal distance is equal to K16.

3. On-scene authorities will determine minimum withdrawal distances for essential personnel.

4. K105 distance is determined by: $D=105W^{1/3}$ or $D=KxW^{1/3}$

5. The withdrawal distances in this table apply to nonessential personnel only.

6. When accidents occur and there is no fire, the on-scene commander will determine whether to implement withdrawal criteria.

WORKSHEET

Table 3.7-3. Aircraft Mishap Hazards Assessment (Table 1 of 2)

Mishap/Date: ____________________

Aircraft MDS: ____________________

Location: ____________________

CATEGORY	HAZARD	CONDITION	LOCATION
FIRE	Fuel and Fuel Tank		
	Overheated Battery		
	Hydraulic fluid		
	Leaking oxygen		
	Leaking or hot batteries		
	Smoldering materials		
	Smoking on site		
	Cutting tools and other heat generating sources		
	Signal flares		
	Anti-icing fluid		
	Hot brakes and tires		
HIGH PRESSURE SYSTEM	Hydraulic accumulators		
	Hydraulic lines		
	Pneumatic systems		
	Shocks, struts		
EXPLOSIVE	Hot brakes and tire		
	Unspent munitions and warhead		
	Aircraft engine fire bottles (APU)		
	Ejection seat oxygen bottles		
	Liquid oxygen bottles		
	Pylon ejector cartridges		
	Canopy and ejection seat devices, drogue gun		
	External fuel tank ejector cartridge		
ELECTRICAL	Power lines		
	Live wires		
RADIOLOGICAL	LANTRIN POD		
	Nuclear weapons		

Table 3.7-3. Aircraft Mishap Hazards Assessment (Table 2 of 2)

Mishap/Date: ____________________

Aircraft MDS: ____________________

Location: ____________________

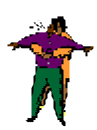
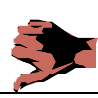
CATEGORY	HAZARD	CONDITION	LOCATION
A/CLIFTING	Unequal weight distribution		
	Incorrect work zones		
BIOLOGICAL	Bloodborne pathogen		
	Poisonous plants		
	Poisonous insects		
	Animals		
TOXIC	Hypergolic rocket and missile propellant		
	Hydrazine		
	Hazardous cargo		
	Battery acid and gases		
	Smoke and smoldering material		
COMPOSITE MATERIAL	AFFF soaked composite debris		
	Damaged Composites: Dust and fiber bundles		
	Aircraft fluid contaminated composites		
ELEMENTS	Heat stress		
	Cold exposure		
Miscellaneous	Sharp objects		
NOTES:			

W O R K S H E E T

Table 3.7-4. Mishap Team Brief Topics (Table 1 of 2)

TOPIC	DISCUSSION	NEED ☑
Site Orientation	Accessibility	
	Location, size of site, topography, confined spaces	
	Environmental conditions	
Safety and Health	Types of exposures (hazard checklist)	
	Hidden fire potential	
	Unspent munitions	
	Procedure for site evacuation	
	Pre-exposure preparation training (CISM refresher)	
	Pathway for hazard substance to be dispersed	
	Composite Material Review	
Personal Protection Equipment (PPE)	Proper use	
	Procedure for equipment failure	
First Aid	Location of first aid kit	
	Emergency eye wash	
	Emergency shower	
Work plan	Objective	
	Work party	
	Worker duties and time to complete work task	
	Work practices	
	Work zones	
	Buddy system and hand signals	
Decontamination Process	Emergency	
	Routine level	
Sanitation for temporary workplaces	Water	
	Toilet	

Table 3.7-4. Hand Signals in Support Of Line-Of-Sight Communications. (Table 2 of 2)

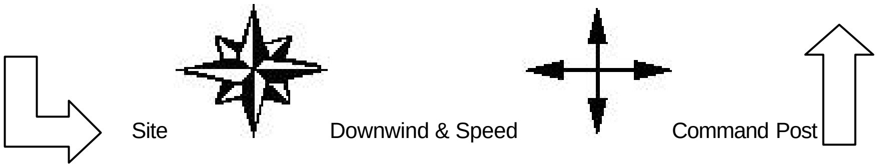
HAND GRIPPING THROAT 	OUT OF AIR OR CAN'T BREATHE!
GRIP PARTNER'S WRIST or   BOTH HANDS AROUND WAIST	LEAVE AREA IMMEDIATELY!
 HANDS ON TOP OF HEAD	NEED IMMEDIATE ASSISTANCE!!
THUMBS UP 	OK OR I AM ALL RIGHT OR I UNDERSTAND!
THUMBS DOWN 	NO, NEGATIVE!
THUMB AND INDEX FINGER TOUCHING TO  FORM A CIRCLE	ARE YOU OKAY?

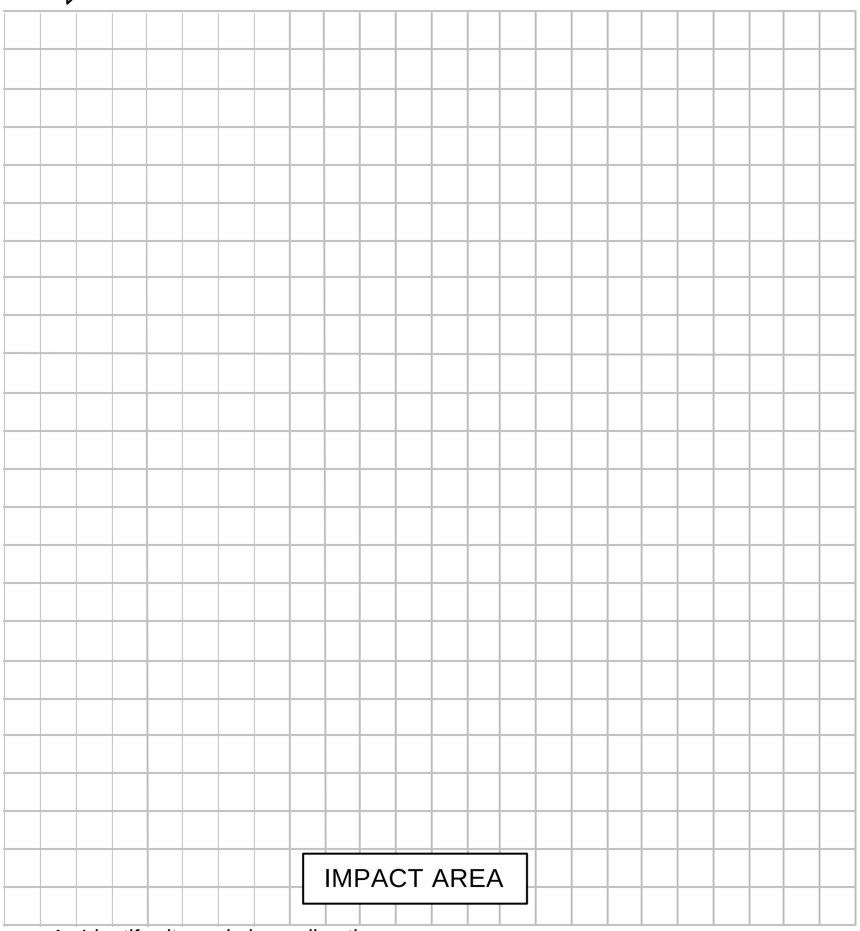
WORKSHEET

Table 3.7-5. Hazard Analysis Sketch - Expanded Sketch Area (Table 1 of 2)

Mishap/Date: ____
Aircraft MDS: ____
Site Location: ____

Directions



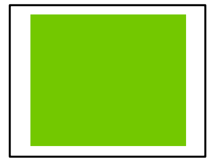


1. Identify site and plume direction.
2. Sight along the centerline of the wreckage path.
3. Locate 4 corners of debris.
4. Site entry control point (ECP).
5. Sketch crater or scar marks.
6. Identify major aircraft parts.
7. Identify composite parts.
8. Loccate Hazards: see checklist
9. Sketch bloodborne pathogen area

ACCURACY IS NOT NECESSARY!!!

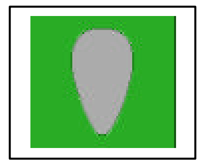
Weather during incident ___
____
Terrain Description_______
____
____

Land or Ground Mishap



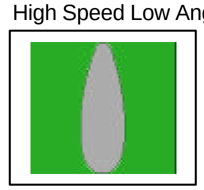
Describe here

High Angle High Speed Impact:



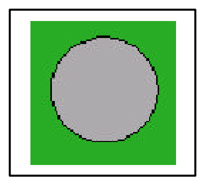
Deep Crater. Wreckage spread is short and wide.

High Speed Low Angle Impact



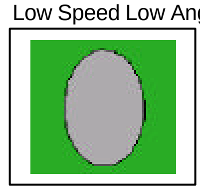
Shallow Crater. Wreckage is long and narrow. Heavy parts are furthest away.

Low Speed High Angle Impact



Wreckage is centralized.

Low Speed Low Angle Impact

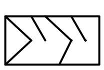


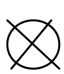
Ground scars leading to wreckage Fracture along primary structure.

AIRCRAFT DEBRIS MAY TUMBLE SEVERAL TIMES BEFORE REACHING ITS FINAL LOCATION AT THE SITE.

W O R K S H E E T

SYMBOLS

Highest concentrations 

ECP 

Bloodborne pathogen ++++

COMPOSITE TERMINOLOGY

Form:		Damage:
	tape	fragments
	fabric	strips
	layer, ply	cluster
	stack	fiber bundles
	filament wound	dust
	solid laminate	single fibers
	sandwiched laminate	delaminated
	core material	scorched

Table 3.7-5. Hazard Analysis Sketch - Expanded Sketch Area (Table 2 of 2)

Site Direction **Plume Direction**

1. Identify site and plume direction at top of page.
2. Sight along the centerline of the wreckage path
3. Locate 4 corners of debris
4. Sketch site entry control point (ECP)
5. Sketch crater or scar marks
7. Identify major aircraft parts
8. Identify composite parts
9. Locate Hazards: see checklist
10. Sketch bloodborne pathogen area

ACCURACY IS NOT NECESSARY.!!!

WORK SHEET

Table 3.7-6. Composite Assessment Questions
(Approximations are adequate)

		COMMENTS
Location	indoor outdoor	
Terrain	description	
Weather conditions at the time of occurrence	wind direction, velocity, temperature, description	
Cause of damage	fire, physical, explosion	
Fire conditions		
Where started	in-flight, impact, other	
Type	fireball, pool, smoldering	
Aircraft location		
Size		
Duration		
Ignition source		
Major fuel source		
Other burning materials		
Fire extinguishment		
Overhaul		
Material Damage (if hazards sketch isn't available)	Description of distribution or spread around the site	
Work Process	Type	
Weather conditions at the time of work process	Wind direction, velocity temperature, description	
Air disturbances at the time of work process	Other than weather	

Weather Description	**Composite Forms**	**Damaged Composite**	**Work Processes**
Hail Sleet Fog Drizzle Rain Snow Thunderstorm Gusty wind Freezing rain Sunny	Tape Fabric Layer Stack Filament wound Solid laminate Sandwich laminate Core material Fibers Resin/matrix	Fragment Strips Cluster Fiber bundles Dust Single fibers Scorched Delaminated	Overhaul Visual Inspection Cut, pry, saw, pound Search & rescue Cleanup Sorting Disposal Other

W O R K S H E E T

Table 3.7-7 Composite Particulate Hold-Down Solutions

HOLD-DOWN SOLUTION TYPE	COMMON NAMES	PURPOSE
PAA (polyacrylic acid) fixant	Floor Wax Carboset 525 Fixant, Hold Down per AMS-F-24610	Temporary surface coating to hold down loose debris that could become airborne when working around the debris at the mishap site. PAA fixant can be removed if the sprayed piece needs to be analyzed for investigation reasons PAA has environmental concerns. Try not to over spray the ground.
Permanent fixant	CPC or Corrosion Prevention Compound per MIL-C-16173, Grade 4	Permanent coating for long-term scrapped debris storage. It is not sprayed on debris that may need laboratory analysis.
Tackifier	Polychem, J-Tack, or Terra Tack™	Soil preparation used to eliminate the potential of fiber and dust re-suspension. Tackifier is used to keep hay and straw mulch from becoming airborne and from road dust from becoming airborne. There shouldn't be an environmental concern when using it to hold down dust.

NOTE:

- Carboset requires very specific mixing conditions. If manufacturer's instructions are not followed, the hold-down property of the fixant will be reduced.
- Light oil is not used as a fixant.
- CPC was chosen as a permanent fixant through laboratory testing.
- Spray paint was a permanent fixant suggestion during the "CORKER" days.

Flowchart 3.7-8. Site Hazards / Fixant Application

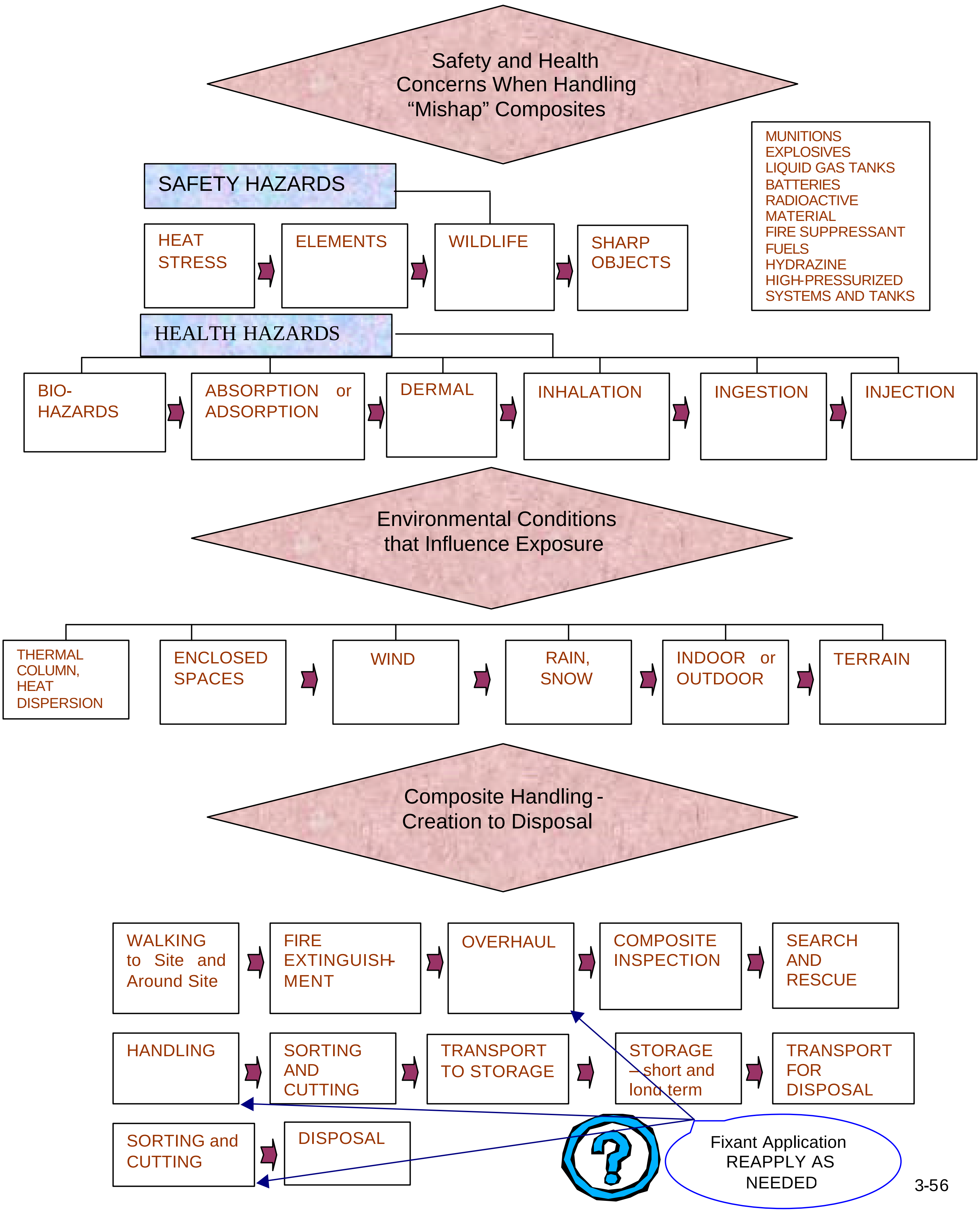


Table 3.7-9. Emergency Response Equipment, Apparel and Supplies

COMMUNICATION EQUIPMENT	HAND-HELD RADIO	NEED ☑
Protective Equipment	Air purifying respirator with dual cartridge (particulate and organic vapor)	
	Disposal respirator N-100 particulate	
	Safety goggles/glasses	
	Mask shield defogger	
	BDU	
	Long sleeve and pant leg	
	Hooded Tyvek Coveralls	
	Hard sole work boots	
	Hard sole and toe boots	
	Hard hat	
	Gloves (liquid chemical resistant, dust resistance, puncture resistant)	
	Biohazard supplies	
	Disposable garbage bags	
	Antibacterial wipes	
	Cleaners & toilettes (alcohol free)	
	Cool vest	
	Cold pack	
	Windbreaker Wet Weather Gear Cold Weather Wear	
First Aid	First Aid Kit, general purpose	
	Including: metal tweezers, hydrocortisone, burn ointment	
	Heat stress indicator	
	Portable eyewash	
	Portable wash unit Thrust quench Magnifying glass	
Field Equipment	Adsorbent Material for fuel spills	
	GPS	
	Compass	
	Binocular	
	Wind Speed Indicator	
	Wind Direction Indicator	
	Temperature Indicator	
	Infrared Sensor	
	HEPA Vacuum	
	Floodlights and flashlight	
	Duct Tape	
	Batteries	
	6mil plastic sheeting, canvas	
	Felt tip marker Shipping Labels Back Pack Sprayer Fixant, 10 gallon water container Rescue tools and multi-pliers	
Reference Material	T.O. 00-105E-9, Chapter 3 and aircraft specific chapter	
	Local Checklist	
	Pertinent tables, checklist or worksheet from paragraph 3.8.	
	Hazards Analysis Sketch, Team Brief Topics, UXO chart	

WORK SHEET

Table 3.7-10. Major Aircraft Terminology Used At Crash Sites

Radome	Engine	Missile
Forward fuselage	Engine Air Inlet	Gun
Center fuselage	Power train	External Stores
Aft fuselage	Powerplant	BDU
Horizontal tail or stabilizer	Landing gear	Ammunition Drum
Vertical fin	Wheels	Nitrogen bottle
Vertical Stabilizer	Speedbrake	Hydrazine bottle
Stablator	Throttle	Liquid Oxygen Bottle (LOX)
Rudder	Flight control equipment	LATRIN
Wing Box	Actuators	POD
Flaperon	Accumulators	Chaff/Flare Dispensers
Leading Edge Flap	Hydraulic reservoir, gauges, or filter	Escape System Pyrotechnics
Trailing Edge Flap	Fuel pump	-Shield Mild Detonating Cord
Control surfaces	EPU	-Initiators (on seat, cockpit)
Canopy*	AOA	-Explosive transfer sequencers
Doors*	Tail hook	-Mounted on panel or bulkhead
Hatches*	Warning system	-Rocket catapult (behind seat)
Panels	Electrical System	-Rocket pack (under seat)
Emergency Exits*	Fuel System	
Emergency Windows*	Pneumatic	
Pylon	Avionic	
	Fuel tank/cell	
***These items may be explosively loaded, use extreme condition.**		

3.8 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Level of protection for aircraft mishap response can drastically change from initial response to the secondary role response. Selection can be complex. Personal protective equipment considerations are based on the operation, site conditions and debris type, condition and amount. To assist with the selection a number of tables have been developed. Use protection in accordance with level of exposure encountered.

a. EPA DESIGNATED LEVELS. EPA levels of protection (A, B, C, D) can be used as a starting point when assembling a protective ensemble. A table describing the levels of protection is found on the following page.

- Note that the lists are provided as a starting point and the ensemble must be tailored to the specific situation.

- Note that the EPA levels of protection were developed around a liquid chemical or gas spill and not airborne particulate or sharp objects on the ground.

- Note that a secondary response operation would not take place if a situation developed warranting a Level A or B ensemble.

- Note that firefighters turnout clothing is considered level D from a hazardous materials perspective.

- The protection level for composite materials will depend on the handling activity performed.

- Development of "hazmat" garments doesn't consider bloodborne pathogen as one of the primary contamination concerns. A garment has not been specifically designed with a dual-purpose concern for aircraft mishap and BBP (i.e. BBP and JP8 fuel or BBP and fiber punctures).

b. PPE SELECTION CHOICES

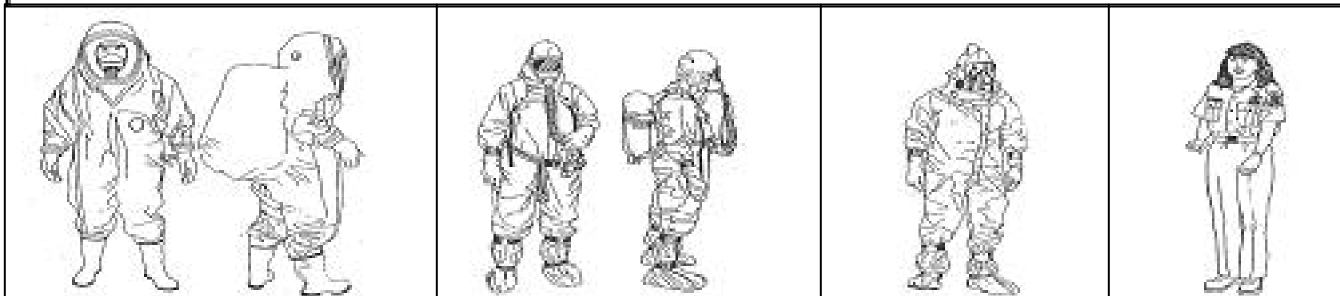
Until recently most hazardous material garments were made by starting with a Tyvek layer. Additional layers are applied to the Tyvek layer for other protection needs like biological warfare, chemical splashes or corrosive gases. Mishap response requires more than one type of glove. Leather, cowhide or Kevlar is chosen for fiber puncture resistance and sharp or jagged metal and glass. Plastic gloves are chosen for chemical and particulate resistance and there are a number of plastic gloves to choose from. PPE choices should be realistic to the exposure because wearing PPE can introduce potential work problems (limited visibility, reduced dexterity, claustrophobia, restricted movement, suit breach, insufficient air supply, dehydration, heat stress) and costs increase dramatically with an increase in the level of protection. The garment selection depends on the route of exposure, degree of contact, and the work process. Because the selection of suits and gloves can become complex a summary is provided in the following tables. The summary is not all-inclusive. Selection should consider dual protection needs.

QUICK REFERENCE TABLES. A number of tables are provided to assist with understanding the use of PPE.

TABLE	TITLE	NUMBER OF TABLE PAGES
3.8-1	EPA Levels of Protection	1
3.8-2	Garment Summary	1
3.8-3	Detailed Garment Description	2
3.8-4	Glove Selection Guide	1

Table 3.8-1 EPA Levels of Protection and Protective Gear

LEVELS OF PROTECTION	HAZARD
LEVEL A	Greatest level of skin, respiratory and eye protection is required.
LEVEL B	Highest level of respiratory protection but with a lesser level of skin protection.
LEVEL C	Concentration of types of airborne substances are known and criteria for using air-purifying respirator is met.
LEVEL D	A work uniform providing minimal protection for nuisance contamination only.
Ref: 29 CFR Part 1910.120	



LEVEL A	LEVEL B	LEVEL C	LEVEL D

REQUIRED + OPTIONAL

EQUIPMENT POSSIBILITIES	LEVEL A	LEVEL B	LEVEL C	LEVEL D
SCBA	#	#		
Full-face air purifying respirator			#	
Encapsulating gas-tight suit	#			
Chemical resistant clothing		#	#	
Coverall (not chemical resistant)				#
Chemical resistant inner/outer glove	#	#	#	
Chemical resistant boots with steel toe	#	#	#	
Two way radio	#	#	#	
Hard hat	+	+	+	+
Faceshield		+	+	+
Safety glasses or splash goggles				#
Disposable boot covers	+	+	+	+
Gloves (not chemical resistant)				+
Escape mask		+	+	+
Safety boot (not chemical resistant)				#

Table 3.8-2. Garment Summary

COVERALLS	BARRIER
Biological	NexGen™ Tychem® (several types) MedProtect
Chemical	
Liquid	Tychem®- several types, Pro/shield 2, NexGen
Hydrazine	Tychem® F, SL and TK
JP8	Tychem® TK (other Tychem® types were not tested)
Sharp object cut	No garment listed provides 100% protection. Tychem® types are more rugged than Tyvek®.
Fiber puncture	Tyvek® types will provide adequate fiber protection for most fiber. Boron fiber may puncture Tyvek®.
Dry particulate	Tyvek®, New Tyvek®, Tyvek® Type and 1431N, 1422, Pro/Shield 2, NexGen
Radioactive dust	Tyvek® Type 1422, Tychem® SL, New Tyvek®

NOTE:
- NOT A COMPREHENSIVE LIST
- NexGen and Tychem is not recommended if BBP is the only exposure concern
- CONSIDER DUAL PROTECTION NEEDS (i.e. BBP and composite puncture wounds, composite puncture wounds and hydraulic fluid)

Table 3.8-3 Detailed Garment Description (Table 1 of 2)

COVERALL	BARRIER	COMMENTS
Tyvek® Olefin fabric	Dry particle and aerosol hazards. Light splash. Dry chemical, dirt and radioactive dust. Seams: stitched Color: white	• Not flame resistant. Should not be used around spark or potentially flammable or explosive environments • Not liquid resistant • Not blood-borne pathogen resistant (ASTM F1670) • Not breathable • Seams are not sealed
New Tyvek® Tyvek® fabric that is softer, more comfortable prior to 2001	Dry particle and aerosol hazards. Dry chemical, dirt and radioactive dust. Anti-static treated Seams: stitched Color: white	• Not flame resistant. Should not be used around spark or potentially flammable or explosive environments • Not liquid resistant • Not blood-borne pathogen resistant (ASTM F1670) • Seams are not sealed

NOTE

The following garments are primarily designed to protect against liquid and vapor exposure, handling quantities of hazardous waste.

COVERALL	BARRIER	COMMENTS
Tychem® QC Tyvek® fabric coated with polyethylene	For minor chemical spills where there is a potential for mist or light splash Color: bright yellow Seams: stitched or taped	• EPA mid-level protection
Tychem® SL Tyvek coated with Dow Saranex® 23-P film	Protects against a broad spectrum of chemicals. Hazardous materials response, radioactive environments, environmental cleanup, some chemical warfare agents, biohazards. Strong fabric, rugged and durable. Color: white, Seams: stitched or NSR®	• EPA mid-level protection • Available in different seam types • Biohazard protection
Tychem® BR Multi-layer film barrier	Protects against moderate to heavy chemical splash. 50 chemicals protection. Strong abrasive resistant fabric. Color: bright yellow, seams: taped	• EPA mid-level protection • Designed for industrial hazmat situations
Tychem® LV Multi-layer film barrier	Same chemical resistance as BR but in a color for military operations Protects against moderate to heavy splash Color: military olive green, seams: taped	• Marketed for military use
Pro/shield® 1 Nonwoven fabric	Non-hazardous light liquid splash Breathable, antistatic treated Color: white or blue, seams: switched	• To avoid nuisance contamination • General maintenance work
Pro/shield® 2 Breathable film and nonwoven fabric	Particles and some toxic liquids Light weight, soft, strong, breathable, anti-static treated Color: white, seams: stitched or NSR®	
NexGen™ Breathable film and nonwoven fabric	Particles and some hazardous liquids Blood-borne pathogen resistant Antistatic treated Color: white, seams: stitched or NSR®	

Table 3.8-3. Detailed Garment Description (Table 2 of 2)

ACCESSORIES	BARRIER	COMMENTS
Over the shoulder Tyvek® or SARANEX® hood	Fiber puncture wounds Composite dust	• Protection when the garment doesn't include a hood
Tyvek® sleeve protector	Fiber puncture wounds Composite dust	• Good for composite inspection with slight hand movement when not wearing a garment
Tyvek® boot cover	Dust	• Not liquid resistant • Will tear walking around a crash site
Cool-Guard® jacket	Heat stress One-size fits all garment, cooling for several hours, more efficient than ice.	• Expensive • Added weight
Chem-Tape®	Used to attach components of a protective ensemble and to reduce the possibility of gross liquid flow at interfaces: sleeve-to-glove, ankle-to-boot, hood-to-face and storm flap	• Duct tape can be used to protect against dust and can remove dust from surfaces.
Kevlar sleeve with leather forearm	Cuts, abrasion and puncture resistant.	• Made for glass and sheet metal handling • Could be used for damaged composite handling for extraction protection
Leather riding chaps Welding leg protection	Sparks from rescue saw	No garment listed will protect against sparks or fire (firefighting turnout clothing only)
BOOTS	**BARRIER**	**COMMENTS**
Rubber Boots with steel midsole and toe	PVC boots Chemical resistance and puncture resistance	• Easy to pull on and off. • Slip resistance • Easy to clean • Usually knee length
Non-rubber firefighting boot	Waterproof, flame and cut resistant. Resists oil, heat and slips. Puncture resistant bottom and steel toe.	• More comfortable than rubber boot and not has hot • More expensive than rubber boot
Air Force boots:		
Hot weather	Fabric upper may not prevent puncture wounds or cuts. Spills may degrade fabric.	
Combat field	No steel toe or shank	
Jump	No steel toe	
"MACH" hot weather	No steel toe or shank. Fabric may not prevent puncture wounds or cuts. Spills may degrade fabric.	
Steel toe tropical or hot weather	Fabric may not prevent puncture wounds or cuts. Spills may degrade fabric.	
Lessons Learned: • Stitched seams will split during operation if the suit doesn't fit properly. Common for broad shoulders individuals. • Front zipper without flap will unzip during operations. It needs to be taped. • Elastic hood closure, wrist and ankles recommended over open wrist, ankle and tied hood closure. • Boot covers are cumbersome if they are too large. Can cause tripping or slipping. Boot covers were not designed for mishap sites. They will rip if there is a lot of movement around the site.		

Table 3.8-4. Glove Selection Guide

Neoprene	Freon Burnt Kapton Hydraulic fluid, gasoline, hydrazine, "decon" fluids
Leather, Kevlar	Boron fiber puncture (not complete protection) Carbon fiber puncture Radioactive material
Nitrile[8] Thick nitrile	Composite dust JP8 soot Bloodborne pathogens (BBP) Antifreeze Hydrazine Gasoline Kerosene Hydraulic fluid Jet fuel BBP decontamination solution Fiber puncture (not Boron fiber)
Latex[9]	Bloodborne pathogens
Butyl –rubber	Battery electrolyte Chemical warfare agents Antifreeze BBP decontamination solution Fire exposed AFFF Burnt Kapton Hydrazine
NOTE: • NOT A COMPLETE LISTING • Never have enough gloves. • Gloves too thin require frequent changes. • Only powder-free gloves. • Get the right size. Mishap response involves manual labor. The wrong size will interfere with the job. • Close-fitting gloves should be used to avoid catching on protruding objects. • Short-cuffed gloves will not protect forearms from fiber puncture wounds. • Effectiveness of the plastic gloves depended on the thickness.	

[8]. The selection criteria are based on minimizing the number of gloves needed.
[9] Inner liners can be used for latex sensitive personnel.

APPENDIX A. ARTICLE – DEPLETED URANIUM

a. WHAT IS RADIATION? Radiation is defined as the process of emitting radiant energy in the form of waves or particles; alpha particles, beta particles, gamma rays, and x-rays are all examples. Radiation can be emitted by radiation producing devices (i.e. medical x-ray machines) or from radioactive materials. Many radioactive materials exist naturally in the environment; uranium is an example of one of these.

b. WHAT IS DEPLETED URANIUM (DU)? DU is a byproduct of the uranium enrichment process and is natural uranium depleted in the isotopes U-234 and U-235. Natural uranium ore contains three isotopes in the following weight percentages: approximately 99.3% U-238, 0.7% U-235, and trace quantities of U-234. After enrichment, the DU byproduct material contains a lower percentage of U-234 and U-235, and thus a higher percentage of U-238 (typically 99.7%). This "depletion" of U-234 and U-235 leaves the DU in a less radioactive state, than naturally occurring uranium. Due to the high abundance and low fabrication costs of DU, industry and the military have made extensive use of DU. The military is using DU in munitions, shielding, and counterweights.

c. WHY USE DU AS A COUNTERWEIGHT? DU is used as counterweights due to its high density (over 1.5 times that of lead), favorable material properties, low cost, high density making it ideal for aircraft counterweights where space is often limited. Counterweights may be found in aircraft gyroscopes, flight controls, helicopter blades, elevator balances, and aileron balances.

d. WHAT ARE THE HAZARDS FROM DU? When handled properly, DU produces very little hazard to the worker or associated personnel. However, there are some hazards associated with DU that must be understood by personnel prior to working with the material.

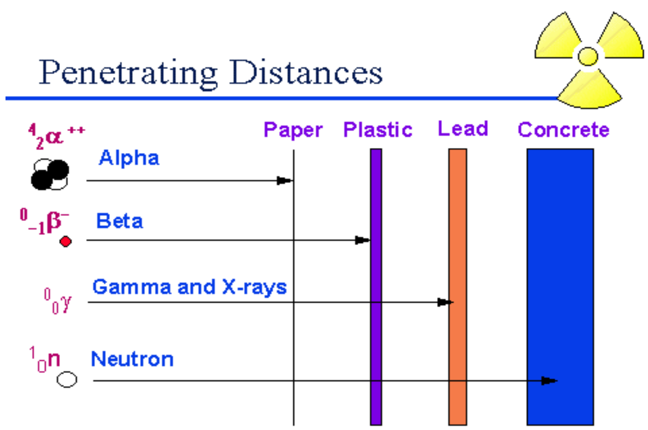
e. RADIATION HAZARDS FROM DU. DU is a low level radioactive material. DU emits alpha and beta particles, and gamma rays. Alpha radiation exposure is most hazardous when DU is ingested, inhaled, or otherwise internalized into the body. Beta radiation is primarily a skin exposure hazard when DU is in close proximity to the body. Gamma radiation exposure is normally not a significant hazard from DU, since a significant fraction of the gamma rays emitted are self-absorbed by the DU.

(1) ALPHA PARTICLES. Alpha particles are easily shielded and cannot even penetrate the dead layer of skin. They present no external radiation hazard but are an internal radiation hazard under certain conditions. If DU is inhaled or ingested, the emission of alpha particles can cause localized cell damage. The most significant adverse health hazard from this low level exposure is the risk for cancer induction.

(2) BETA PARTICLES.?Beta particles possess a greater ability to penetrate materials than alpha particles. Like alpha particles, beta particle emissions present internal radiation hazards if internally deposited. Externally radiation hazards are only significant for close proximity/prolonged exposures.

(3) GAMMA RAYS. Gamma rays are the most penetrating of the radiations emitted by DU. The exposure rate at 1 inch from a typical source is 7 mrem/hr, but drops to undetectable levels at a distance of about one to two feet from most DU counterweights.

The following diagram summarizes the penetrating ability of the three radiations.



f. CHEMICAL HAZARDS FROM DU. Ingestion or inhalation of DU may pose a chemical toxicity hazard. Once DU enters the lungs much of it is dissolved in the blood. It is then dispersed throughout the body and concentrates primarily in the kidneys, bones, and liver, remaining there for years. The metabolism of DU by the body can damage tissues. These chemical effects include kidney damage, and can be more serious than those caused by the radiation if the exposure is acute.

g. PHYSICAL HAZARDS FROM DU. DU can be an internal exposure problem when inhaled or incorporated into the body through ingestion or open wounds. The degree of risk from inhaled DU is directly related to the particle size and exposure duration. A burning piece of DU can emitted highly respirable particles (1-10 um AMAD), and thus a DU fire (exhibited by white smoke) should always be considered an internal exposure hazard. Ingestion or incorporation of DU into open wounds can also be a hazard. However, due to the relatively insoluble nature of DU, inhalation exposure is considered the greater risk. Appropriate emergency response actions should always be taken during and after a DU fire. These actions include crash site entry upwind, use of respiratory protection (SCBA or HEPA filtered mask) if available, and radiation surveys and decontamination of all personnel and equipment exposed to fires involving DU. Treatment of life threatening injuries always takes precedence over radiation surveys or decontamination. DU exposure, whether external or internal, is always accompanied by some health risk, however during most aircraft accidents, the risk from other hazards (UXOs, jet fuel, composite materials, and various organic compounds emitted during a aircraft fire heavily outweighs the risk from DU exposure. This is due primarily to the relatively low specific activity of DU and its low solubility when exposed to high temperatures (i.e. UO^2 form).

h. <u>HOW DO I PROTECT MYSELF FROM DU HAZARD?</u> External doses from DU are easily controlled by standard health physics practices of reducing <u>time</u>, increasing the <u>distance</u>, and using <u>shielding</u> around counterweights. Wearing gloves will prevent skin contact and reduce beta exposure when handling DU. Protective respiratory masks are needed if DU dust exists. Dust from DU is common when the material undergoes oxidation (the material turns from silvery-white to a black or brownish color). When in this state, the dust should be suppressed by atomized water spray. As an internal radiation hazard, thermo-luminescent dosimeters and other monitoring devices do not provide any reduction in exposure.

i. <u>HOW MUCH RADIATION AM I BEING EXPOSED TO</u>? We are exposed every day to radiation that occurs naturally in the environment. This background radiation comes from cosmic and terrestrial sources that exist in food, water, and the air. On average, Americans receive 350 mrem per year from background radiation sources. Through safe handling practices, radiation from DU will be significantly less than these background sources. By Federal law, dose limits to members of the general public are 100 mrem per year. As well, the Air Force applies this limit to non-radiation workers including most aircraft maintenance personnel.

j. <u>SAFE HANDLING INSTRUCTIONS FOR DU.</u>

(1) No drilling, filing, machining, sanding, or other abrasive procedures are permitted.

(2) Where prolonged body contact is possible or where abrasive operations are likely to affect the DU, DU parts will be removed and stored in secure areas.

(3) Skin contact should be avoided. Heavy gloves should be worn if handling is required. DU with damaged plating will be wrapped and sealed in plastic bags or wrapping material.

(4) Industrial eye protection and approved respirators will be worn when removing or handling damaged or corroded DU.

(5) Materials used in handling corroded or damaged DU (such as gloves or plastic wrap) will be bagged in plastic and placed in radioactive waste containers for disposal IAW applicable technical orders.

(6) Personnel handling DU will wash hands thoroughly with soap and water immediately after removal of gloves, before eating, drinking, and smoking or at the end of work shifts.

(7) The Radiation Safety Officer should survey areas where corroded DU has been handled or stored.

(8) DU waste will be disposed of IAW AFI 40-201 and shipped IAW applicable Federal regulations (10 CFR & 49 CFR).

For further information or, in the event of a potential DU overexposure, contact your local Bioenvironmental Engineering (BEE) office or Medical Treatment Facility for urgent care.

Depleted Uranium (DU) Counterweight Safety

For more information on DU safety contact the AFIERA Radiation Surveillance Division through The ESOH Service Center
1-888-232-ESOH or DSN 240-5454

APPENDIX B. ARTICLE – UNDERSTANDING THE SAFETY HAZARDS ASSOCIATED WITH OPTICAL ELEMENTS COATED WITH RADIOACTIVE MATERIALS.

Understanding the Hazards Associated with using Optical Elements Coated with Radioactive Materials

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Keywords: radioactive materials, handling, optical coating, thorium

Abstract

Most Forward Looking Infrared (FLIR) systems and CO_2 lasers are still using optical elements coated with radioactive materials due to performance and environmental requirements despite the fact that radioactive materials are very costly to properly handle and dispose. There have been great efforts made to eliminate the use of optical elements coated with radioactive materials however, without optical coatings, the transmittance performance of only 46% is obtained in the 8 to 14 micrometer region. The optical coating most commonly used in most FLIR and CO_2 laser systems contain small amounts of thorium tetrafluoride (ThF_4), also known as Thorium Fluoride. The use of ThF_4 as one of the multi-layers in antireflective coatings produces a 98% transmittance within the 8 to 14 micrometer region.

Today, in most cases, it is evident that optical elements coated with radioactive materials are critical to the successful and safe operations of most all infrared optical systems. However, companies that choose to use such optics have placed upon themselves a huge responsibility of safely handling and disposing of the radioactive materials.

Introduction

The use of optical coatings for obtaining superior spectral performance is achieved over wide wavelength ranges using Single Layer Anti-Reflection (SLAR) / Multi-Layer Anti-Reflection (MLAR) coatings. Both MLAR and SLAR coatings are designed to increase substrate transmission and reduce surface reflection for specific wavelength intervals. ThF_4 is optimum since it is one of the heaviest fluoride compounds currently available, and its lattice absorption region is well beyond the 8 to 14μm operating region of most FLIR systems. Although the use of ThF_4 greatly enhances performance, it creates a huge responsibility on companies to operate a safe working environment for its' employees as well as the end users due to ThF_4 for the most part consisting of Thorium, Th^{232}, which is a naturally occurring radioactive material.

This paper will discuss the safety hazards and costs associated with using optical elements coated with radioactive materials, such as ThF_4 in accordance with state and/or federal regulations. This paper will identify suggested procedures for safe handling of such optics to ensure no hazardous levels of radiation will be experienced during equipment use or handling. This paper will also discuss suggested guidelines and procedures for disposing of any damaged optical elements as well as discuss conducting periodic work area surveys to ensure no hazardous levels exist.

Ionizing Radiation

Thorium's naturally occurring radiation comes from its decay process. During its' decay process its' decay products, called thorium daughters, and their next decay products emit ionizing radiation, primarily in the form of alpha particles. Thorium and its decay products also emit some beta particles and gamma radiation, see figure 1. Exposure to ionizing radiation is dangerous for humans and exposure to any amount can induce malignant changes in tissue or damage the body in other ways.

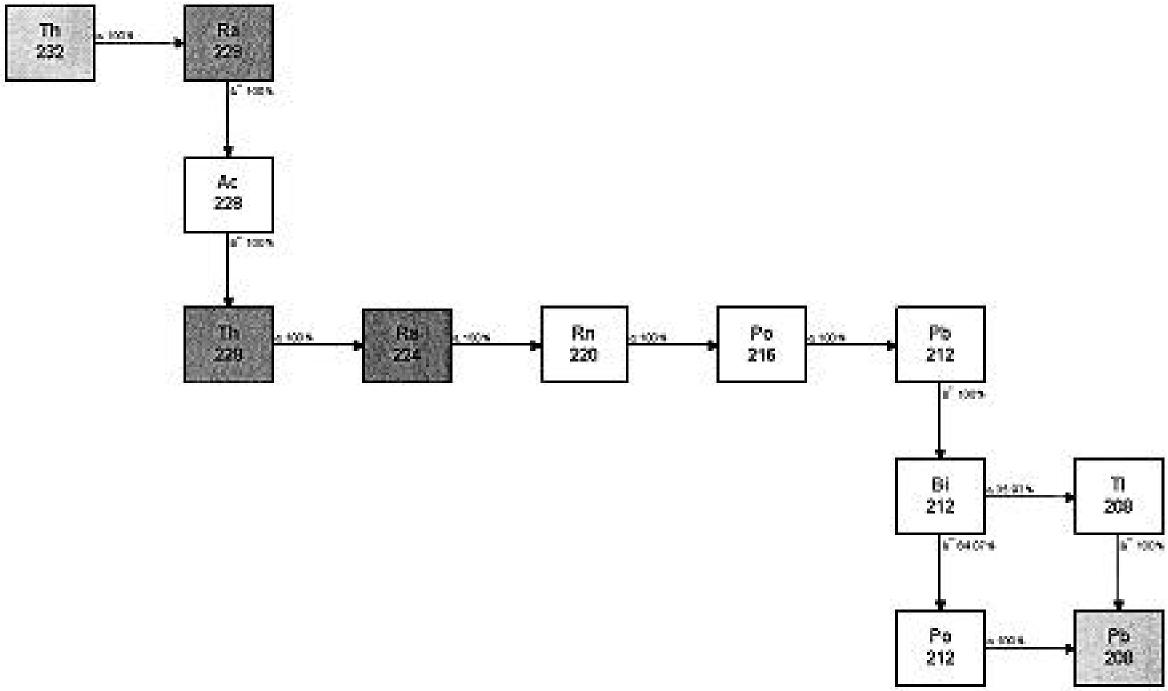

Figure 1 - Thorium Decay Process

Radiation Effects

Biological effects due to ionizing radiation exposure may be grouped into those resulting from acute and/or chronic exposures.

Acute Effects: Acute or short-term whole body radiation overexposure may affect all of the organs and systems of the body. Characteristic acute effects include nausea and vomiting, malaise and fatigue, increased body temperature, and various blood changes. Not all organs and organ systems are equally sensitive to radiation, and therefore the physiological response in an overexposed individual depends on the level of the dose.

Chronic Effects: Delayed effects resulting from radiation exposure are generally due to long term, or chronic, exposures. These effects generally include cancer, genetic effects, shortening of lifespan, and cataracts. Radiation of the skin by an external source is a means of producing chronic effects. Chronic effects may also result from a single exposure to radioisotopes which become lodged or absorbed in the body tissues. Such internal emitters represent the greatest source of chronic effects.

Radiation Particles

Alpha Particles: Alpha particles do not pose an external hazard because they cannot penetrate human skin, they can be stopped with a sheet of paper, and because they have a short range. In comparison to other subatomic particles alpha particles are quite large, as a result they lack penetrating power. However, if inhaled or ingested, the particles can come in direct contact with tissue cells and cause damage, often times severe.

Beta Particles: Beta particles constitute an external hazard due to their longer range and ability to penetrate the skin to varying depths, depending on the energy of the particle. Some beta particles have sufficient energy to penetrate human skin and cause skin burns. Upon deceleration of the particle within the tissue, betas give rise to highly penetrating X-rays called Bremsstrahlung. Beta particles can cause damage if inhaled or ingested.

Gamma Particles: Gamma rays (or particles) are similar to X-rays, but extend into the shorter wavelength region of the energy spectrum. Gamma rays are high-energy emissions that easily penetrate human skin. Gamma rays are more penetrating than betas and destroy tissues in a manner similar to X radiation, i.e., through ionization by the photoelectric effect and pair production.

Particle Effects

Of the particles emitted during decay, alpha particles pose the least threat, since their range and penetrating energy are low and they cannot pass through skin. Beta and gamma particles do not present as much of a hazard from an internal emitter standpoint, since they each have a Relative Biological Effectiveness (RBE[1]) factor of one, as compared to 20 for alphas. However, all three particles pose a potential safety hazard if inhaled. Broken or damaged lenses must therefore be handled in accordance with approved shop practices and cleaning procedures.

Suggested Guidelines for Handling, Storing, Transporting and Disposing of Optics Coated with Radioactive Materials

Companies should ensure that all employees who handle optics coated with radioactive materials, i.e., thorium, should be aware of the hazards associated with the materials and how to clean up any broken or flaking radioactive optical lens.

Training: Every employee directly working with or frequently visiting areas that will be using thorium coated optical lenses, must attend a training class conducted by company recognized safety personnel. This class should inform the employees of the hazards associated with radioactive materials and discuss methods to prevent hazardous conditions, such as handling and disposal methods.

Employees should be prohibited from handling radioactive materials until they have completed the class.

Employees should take the course, at a minimum, every 2 years.

The recognized safety personnel for the program using radioactive materials should keep a log of all employees handling optics coated with radioactive materials. This log should record if the employee has completed the training course and when the course was completed. This will ensure that all employees who continuously handle optics coated with radioactive materials are properly trained and informed of any hazards.

General Handling Safety Guidelines: Radioactive materials must never be handled by individuals who have not completed the training class for handling radioactive materials.

Material Safety Data Sheets (MSDS) for all radioactive materials should be available in work area(s).

All storage containers and areas where radioactive materials are stored should be labeled appropriately to make sure everyone is aware of the contents, e.g. **"RADIOACTIVE THORIUM COATED OPTICAL ELEMENTS"**.

Work areas where radioactive materials are being used must have available a calibrated survey meter (e.g. Ludlum or Bicron) with alpha probe.

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[1] RBE factor represents the relative damage producing potential of equal amounts of various radiations.

The survey meter must be calibrated and tagged with date of calibration on a bi-yearly basis, every 6-months.

A radiation survey, see table 1, of the work area(s) should be conducted periodically to determine what kinds of radiation levels exist and to detect any malfunctioning equipment.

Table 1 - General Radiation Survey

Date: ______________________________

Program: ______________________________

Location: ______________________________

Isotope(s): (i.e., Th^{232}) ______________________________

Safety Personnel: ______________________________

Survey Tool Information

Make: ______________________________

Model: ______________________________

Serial: ______________________________

Date of Calibration: ______________________________

YES	NO	N/A	CHECKLIST: (Items marked "No" require corrective
____	____	____	Material Safety Data Sheets (MSDS) available in work area(s).
____	____	____	Employee(s) adequately trained for functions performed.
____	____	____	Radioisotope work area(s), storage area(s), including waste storage, and equipment are labeled adequately.
____	____	____	Food & other consumables are not present in radioisotope work or storage area(s).
____	____	____	Dosimeters, if assigned, and protective equipment used during radioisotope handling.
____	____	____	Laboratory radiation survey equipment calibration current.
____	____	____	Laboratory radiation survey equipment is functional and used correctly.
____	____	____	Surveyed area(s) are free of radioactive contamination.
____	____	____	Work involving radioactive material(s) being performed at time of survey.

Survey analysis results: ______________ **dpm** **or** **microcuries**

Comment(s): ______________________________

____

____

____

____

____

____

Surveyed By: ______________________________

Phone: ______________________________

Suggested Procedures for Hazard Control of Damaged Optical Elements: These suggested guidelines define the procedures for safely handling and cleaning up damaged, broken or flaking, optical elements containing radioactive materials, i.e. thorium coated optics.

Protective Equipment: With damaged optical elements that contain radioactive materials, i.e., thorium, there exists a hazard from the broken glass as well as from the radioactive coating on the glass. In case of breakage, protection will center on protection of the skin from shards of glass and the respiratory tract from thorium dust from the broken or flaking optical element(s).

Protective gloves - leather gloves are recommended to minimize the potential for lacerations.

Chemical goggles - standard lab grade wrap around goggles are recommended.

Respirator - equipped with 0.3-micron HEPA filter. Workers who wear a respirator must comply with the OSHA regulations specified in 29 CFR 1910.134 (Respiratory Protection).

HEPA filtered vacuum cleaner (99.97%) efficient at 0.3 micron particle size.

Storage of Radioactive Materials: All areas in which radioactive active materials are stored must be approved by company recognized safety personnel.

Radioactive materials, such as thorium coated optics, should be stored in sealed containers or packages as to prevent accidental breakage.

All sealed or packaged storage containers should have a label with the following information: quantities and type of materials enclosed, i.e., thorium coated optical elements.

Waste Storage Containers: Proper waste containers should be identified for radioactive materials. Waste should never be placed in normal plant trashcans.

All containers for waste must be labeled appropriately, e.g. **"RADIOACTIVE - thorium coated optical elements" (lens)**.

Containers should have a container log with the following information: the company recognized safety personnel, program name, location, program contact person, type of material, i.e., thorium coated optical elements, date and time of last area survey conducted.

Waste storage containers should be hard-sided, such as a cardboard box, have all damaged optics sealed in 5 mil or thicker plastic bags, if broken, and have a close-able lid.

All containers must remain closed except when adding waste.

When the waste container is full contact the company recognized safety personnel for disposal.

Transportation and Packaging of Radioactive Materials: The following are guidelines that should be followed to prevent accidental breakage of any thorium coated optical lens if the company has multiple facilities that the optics would be shipped for testing, assembly, etc.

Radioactive materials, i.e., thorium coated optics, must be transported in company vehicles only. Transporting radioactive materials, i.e. thorium coated optical elements, in personal vehicles should be prohibited.

The lens, if individually packaged, should be adequately packaged as such to not break when accidentally dropped.

Transportation of radioactive material, i.e. thorium coated optical elements, must be in such a manner as to prevent accidental breakage; use a cart when necessary.

Disposal of Radioactive Materials: Radioactive materials, i.e. thorium coated optical elements, must be sent to a licensed treatment/disposal facility. Most companies have contracts with disposal facilities. The disposal procedure will have to be negotiated for each individual company. Employees handling radioactive materials should be aware of the disposal procedures.

Radioactive Material Clean-up Procedure

Don gloves, goggles and respirator.

Pick up all loose optical element parts and double-bag them in 5 mil or greater plastic bags. Seal the bags with adhesive tape (2" duct tape).

Vacuum all loose material and debris with a HEPA filtered vacuum cleaner.

Carefully open the vacuum cleaner top section and remove the disposable liner. Secure the liner with adhesive tape (2" duct tape).

Deposit the vacuum bag inside a 5 mil or thicker plastic bag and secure with adhesive tape (2" duct tape).

Damp-wipe the inside and outside surfaces of the vacuum cleaner and hose.

Damp-wipe the area and equipment from where the broken/crushed or flaking optical elements were removed.

Deposit all rags in a plastic bag and seal the bag with tape.

Remove protective clothing.

Place the used vacuum cleaner bags and broken optical element bag in radioactive waste storage container.

Close the waste storage container.

Wash hands and face thoroughly, being careful not to abrade the skin.

Record information on waste container log sheet.

Perform a radiation survey, see table 1, of the area to verify that the area is not contaminated.

Notify company recognized safety personnel of incident.

Conclusion

There are companies actively researching possible non-radioactive substitutes for thorium. Until then, there is still a low risk of external radiation exposure when handling generally licensed quantities of thorium compounds. Alpha particles do not pose an external hazard because they cannot penetrate human skin. However, if inhaled or ingested, the particles come in direct contact with tissue cells and can cause severe damage. Some beta particles have sufficient energy to penetrate human skin and will cause skin burns. Beta particles can cause damage if inhaled or ingested. Gamma radiation can easily penetrate the human body. They are, therefore, dangerous in high amounts as external radiation hazards. Each of these particles, if inhaled or ingested can do damage to human tissue to an extent that is dose-dependent – the more radiation the more damage. There is some risk with any dose of radiation exposure however small. The goal of these suggested guidelines is merely to protect employees against unnecessary exposure of these particles until there is an alternative to thorium. Employees should be aware of the hazards associated with the materials they are in contact with and how the procedures to properly handle optical elements that are coated with radioactive materials.

References

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2. RADIOLOGICAL HEALTH HANDBOOK, Revised Ed., U.S. Dept. of Health, Education, and Welfare, Rockville, MD, 1970.
3. Agency for Toxic Substances and Disease Registry, http://www.atsdr.cdc.gov/ToxProfiles/phs9025.html

Biography

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APPENDIX C. MISHAP RESPONSE SUMMARY

Six flight mishap scenarios[10] have been categorized to illustrate the number of possible scenarios (the list can be used to determine what scenario is most likely to occur for a particular installation). There are seven types of mishap classes[11] within the USAF with a different type of response for each mishap class. A mishap can occur on the ground or in-flight causing the aircraft to crash. When a crash does occur there is much participation from many organizations behind the scene (base involvement) and at the mishap site. Mishap response doesn't happen frequently and when it does the response force will be different from mishap to mishap. A mishap response is conducted by following two USAF instructions 32 and 91 Series and is explained by execution of phases. A summary of each phase is given in the order in which they are executed. In a real-world situation some phases of the response will overlap or may not be executed depending on the mishap class. For example, a flight line mishap will speed up the cleanup phase and a Class C mishap may not require an environmental assessment. Terms are defined in paragraph 3.2 and Tables are found at the end of the paragraph.

a. EMERGENCY RESPONSE. The purpose of an emergency response is to control the immediate hazards through USAF 32 Series instructions, manuals, and pamphlets. The emergency response is conducted in four phases: notification, response, withdrawal, and the recovery phase. The base has been notified that a flight mishap has occurred, the DRF and CAT activate and Phase 1 begins.

PHASE I - involves a gathering of information for an immediate response.

PHASE II - the initial response deploys followed by the disaster control group when a safe route has been determined.

PHASE III - instructs the initial response to order a withdrawal when mishap site conditions are unsafe.

When the initial response has controlled the fire conditions, completed rescue and first aid activities and has declared the site safe, the site can be turned over to the DCG for the execution of Phase IV.

Phase IV - site recovery (not aircraft recovery) begins. The on-scene-commander (OSC) will set up control points, establish communications and direct activities of support services in preparation for the arrival of the interim safety investigation board.

b. SAFETY INVESTIGATION RESPONSE. The purpose is to prepare for and conduct a flight safety investigation through USAF 91 Series instructions and pamphlets by day 30. This response is explained in six phases: preparation, notification, interim safety investigation board, permanent safety investigation board (SIB) arrival, investigation, analysis and reporting.

Phase I - occurs before a mishap has taken place. Each installation establishes a disaster response force and a crisis action team. Wing safety develops a Disaster Preparedness Operations Plan (O-Plan 32-1) and identifies potential interim board and possible MAJCOM permanent board members.

Phase II - begins when a mishap has actually occurred. Interim board assembles, MAJCOM owning aircraft notifies individual to serve on SIB and the HQ AFSC appoints officers to serve on the permanent board for Class A mishap.

Phase III- begins when the DCG, OSC turns the site over to the interim safety board. The interim board controls the site, preserves the evidence and prepares for hand-off to the permanent board. The permanent board assembles within 3 days of the event, receives formal briefing from the interim board and then reviews their roles during Phase IV of the mishap.

PHASE V - is the investigation and analysis phase. Investigation, sorting and analysis of the evidence. The what, how and who questions are answered. Base support is critical.

PHASE VI - is the reporting phase that actually begins the moment a mishap has occurred. The final report is assembled according to AF instructions by day 30.

c. HAZARDS AND SAFETY INFORMATION PROCESS. During the emergency response, bioenvironmental engineering (BEE), explosive ordnance disposal (EOD), aircraft maintenance, safety, and the fire department will report specific hazards to the OSC. This information is used to control the site during Phase IV of the emergency response. There is a requirement for each transfer of command to include

[10] A/C from X AF Base crashes at X AF Base
A/C from X AF Base crashes at Y AF Base
A/C from X AF Base crashes at a civilian facility
A/C from X AF Base crashes in isolated area in the Continental United States (CONUS)
A/C from X AF Base crashes near a sister service installation
A/C from X AF Base crashes away from AF facilities outside CONUS

[11] A, B, C, D, L, X

safety and health information. This information is usually given as a verbal form of communication.

d. SECONDARY ROLE RESPONSE. There are supporting roles needed for a major accident. These roles may or may not follow specific USAF instructions. The roles are: reclaim wreckage, transport off site, site cleanup, short-term storage, environmental assessment, long-term storage (years), and the demilitarization process. Functional performing roles during the mishap will be dependent on local base resources. Note that some of the activities during the emergency or safety investigation response may occur simultaneously. Once the debris is removed from the site, it may be stored at various locations for up to seven years before it will be move to the demilitarization site.

e. ACTIVITIES. From the time the mishap debris is created to disposal there are many processes that take place around and with the debris. To avoid injury while responding, safety and health assessment would include knowledge of the mishap processes. Following are some of the activities that could be anticipated.

- firefighting response including overhaul
- walking to and around the site
- ordnance recovery
- debris inspection with hand movement
- mortuary affair land search involving movement of soil and debris
- cutting, prying, sawing, pounding, manual dissembling of debris
- lifting with equipment (CDDAR), backhoe
- site cleanup
    - picking pieces from topsoil
    - sorting
    - packaging and/or crating for transport off site
    - excavating the site – racking, backhoe, digging
    - sweeping
    - transport to short term storage (usually inside)
    - transport to long term storage (usually outside)
    - disposal
    - opening crates
    - sorting
    - cutting with a saw

F. BEHIND-THE-SCENE INVOLVEMENT. The emergency response mission is to preserve life, Air Force resources, property and evidence for the safety investigation that will follow. Local base operation plan 32-1 and safety investigation 91-204 strive to provide rapid notification, correct and timely response, and containment of the mishap situation. The amount of involvement is shown in the following tables.

QUICK RERFERENCE TABLES. A number of tables are provided to assist with the reading.

TABLE	TITLE	NUMBER OF TABLE PAGES
Table C-1	**Emergency Response – Illustration of behind-the-scene involvement.**	**1**
Table C-2	**Emergency Response - Illustration of Possible Site Involvement**	**1**
Table C-3	**Emergency Response Publication**	**1**
Table C-4	**Mishap Impact Crater Signature**	**1**

Table C-1 Emergency Response – Illustration of Behind-the-Scene Involvement. [12]

Wing Operations Center	Operations Group	Logistic Group	Support Group	Communication Group	Medical Group	Interim Safety Board
Wing Commander Wing Staff Judge Advocate Wing Public Affairs Wing Command Post Wing Safety Wing Comptroller	Operations Group Commander Aeromedical Evacuation Squadron Commander Airlift Squadron Commander Operations Support Squadron Commander Airfield Operations Flight Weather	Logistic Group Commander Logistic Support Squadron Commander Maintenance Squadron Commander Supply Squadron Commander Transportation Squadron Commander	Support Group Commander Security Police Squadron Commander Civil Engineer Squadron Commander Mission Support Squadron Commander Information Management Flight Causality Assistance Mortuary Affairs Fire Protection Disaster Preparedness	Commander Communication Squadron Commander Visual Information	Medical Group Commander	President Investigation officer Pilot member Maintenance member Medical Recorder

Table C-2 Emergency Response - Illustration of possible site involvement. [13]

Phase I	Phase II	Phase III	Phase IV
Initial Response: Fire Department Flight Surgeon Security Police Follow-on Response: DCG - OSC Safety Flight Surgeon BEE Crash Recovery EOD Aircraft Maintenance Fuel Systems LANTRIN Photo	Security Police Medic Flight Surgeon Bioenvironmental Engineering Crash Recovery EOD Fuel Systems LANTRIN Photo	Security Police Medic BEE Crash Recovery EOD Fuel Systems LANTRIN Photo OG Environmental Civil Engineering Avionics EWS Services Transportation Flight Safety	Security Police Medic BEE OG Environmental Services Transportation Crash Recovery

[12] The exact notification chain is mishap type and base dependent.
[13] Not a complete list of all possible involvement.

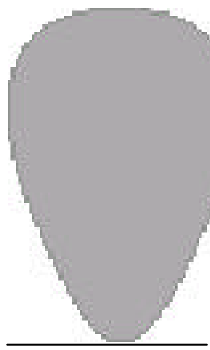
Table C-3. Emergency Response Publication

INSTRUCTION	TITLE	INTENTION	RESPONDER	SECTION OF INTEREST
AFPD32-4001	Disaster Preparedness Planning Operations	Outlines planning, responsibilities at each level of the AF and training requirements	Disaster Control Force Base Civil Engineering (CE)	App 1 list table of SRC composition and responsibilities. Att 2 list functional support. Att 3 provides Base O-Plan guidance
AFPD32-4002	Hazardous Material Emergency Planning and Response Planning	Plan for HAZMAT, Emergency Response	CE	Att 3 has a format for HAZMAT emergency response for OPlan 32-1, Annex A
AFMAN32-4004	Emergency Response Operations	Specific response procedures for the 4 phases of emergency response	Disaster Control Force Base Civil Engineering (CE)	Attachments contain example checklist. Att 3 contains guidance for response involving composites
AFMAN32-4013	Hazardous Material Emergency Planning and Response Guide	Establishing a HAZMAT program	CE	Chapter 8, post emergency clean up and disposal but no composites information
AFH 32-4016 V1 and V2	CE Readiness Flight Response & Recovery Handbook	Summarizes emergency response and recovery considerations.	CE	Includes Hazards Considerations. Volume 2 has an overview of major accident mishap response
AFI91-202	USAF Mishap Prevention Program	Establishes program requirements, responsibilities	Safety staff	Att 4, Mishap Response
AFI91-204	Safety Investigation and Reports	Procedures for investigating and reporting USAF mishaps	Safety staffs, all persons who investigate and report AF mishaps	All
AFPAM 91-211, 1996 draft	USAF Guide to Safety Investigation	Procedures for Investigating and Reporting AF Mishap	Interim and formal SIB	Chapter 2 – interim SIB and hand-off information. Chapter 4, mishap hazards
T.O. 00-105E-9	Aerospace Emergency Rescue and Mishap Response Information (Emergency Services)	Procedures for emergency rescue and mishap response with location of hazards on aircraft	All responder types	Chapter 3, Hazardous Materials, Events, and Response Procedures
AFI 34-242	Mortuary Affairs Program	Search and Rescue Efforts	Mortuary Affairs	Chapter 6 is mishap response

SRC = survival recovery center
MRP = mishap response plans

Table C-4. Mishap Impact Crater Signature

HIGH SPEED - HIGH ANGLE

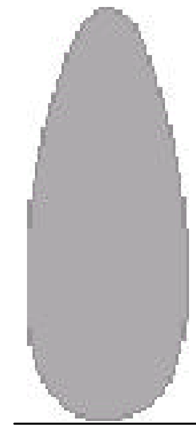


IMPACT POINT

Crater: Deep

Wreckage: Random parts within crater and short wide distribution. Some parts may be short of crater.

HIGH SPEED - LOW ANGLE

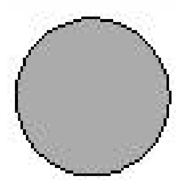


IMPACT POINT

Aircraft skips
Crater: elongated and shallow.

Wreckage: Long narrow path. Breakup from bottom to top. Heavy parts furthest down range.

LOW SPEED - HIGH ANGLE

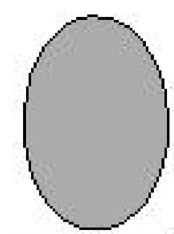


IMPACT POINT

Centralized Wreckage.

Inertial Breakup.

LOW SPEED - LOW ANGLE



IMPACT POINT

Ground scars leading to wreckage.
Aircraft breakup along primary structure -
wing, tail, engine.
Impact forces may be survivable.

APPENDIX D. MISHAP-COMPOSITE AWARENESS

The mishap responder's primary duties do not provide an opportunity to learn about composite system or materials associated with aerospace vehicles. This paragraph contains introductory information that will aid with a familiarization of composite systems pertinent to a mishap scenario. Information in subparagraph (a) and (b) can be used to identify composite debris among the wreckage and provides a common language that will help with communication consistency for all response types.

a. BASICS OF COMPOSITES. Knowing how a composite part is made will help explain what happens when it becomes damaged. See Photo Gallery at the end of this paragraph.

(1) SYSTEM OF MATERIALS. Composites are a SYSTEM of two or more *different* materials. Most common for aircraft manufacturing are man made fibers surrounded by a matrix. The matrix is a resin or plastic material. During the manufacturing process the resin chemically bonds to the fiber and each adjacent layer of material. The resin seals and holds thousands of fibers in place. Without the fiber the resin would be a solid chunk of plastic material. Without the resin the fiber behaves similar to thread used for making clothes or hair found in a hairbrush (Photo 1).

(2) MATERIALS USED TO BUILD AIRCRAFT PARTS.

(a) "PREPREG". Different manufacturing processes are used to make or repair aircraft parts and different material forms are used for each process. One common material form is the "prepreg". "Prepreg" is a fibrous material that has been coated or pre-impregnated with a tacky or viscous resin. It is received from the materials manufacturer in a ready-to-use state.

(b) "PREGREG" TYPES. "Prepreg" is identified by the fiber direction. Fibers are oriented in a parallel fashion for the unidirectional "prepreg" and are weaved into various interlacing patterns for the woven "prepreg". The roving "prepreg" is a collection of fiber bundles and is delivered just like a spool of thread. The unidirectional and the woven "prepreg" are received as a sheet of material wound around a cardboard spool for storage and handling purposes. Because the spool resembles a roll of tape, the material is sometimes referred to as a "prepreg" tape (Photos 2-8).

(3) BUILDING THE COMPOSITE PART. To obtain a specific shape, one way of building a composite is by *stacking multiple layers* of "prepreg" (resin-coated fibers) material around a tool that has the desired shape. The layers of "prepreg" material is produced by cutting the desired size from the spool much like cutting textile fabric used to make clothing. The layers are stacked until the desired thickness is reached. (Photos 9 and 10) To become a solid part the matrix solidifies during a cure cycle. During the cure, the resin chemically attached to each fiber within a layer and between the layers. After cure, the tool is removed and the "prepreg" material now has a permanent shape. The layers are not distinguishable from one another and the part appears to be homogenous. The bulk solid part is considered to be biologically inert to the touch.

(4) AIRCRAFT PART FINISHED FORMS. There are several different types of parts made by layering of materials that can be found at a mishap scene. The solid laminate, the sandwich laminate and the filament wound laminate will be identifiable among the damage debris.

(a) SOLID LAMINATE. The cured part is called a laminate. The laminate can have various forms but the solid laminate is usually referenced to a flat or slightly curved form. This type of laminate is used to make aircraft skins, panels, and doors. Ribs, stiffeners, and spars are other composite applications made by layering of materials. (Photos 11 and 12)

(b) SANDWICH LAMINATE. To reduce the weight of the part a sandwiched laminate was developed. A lightweight core material is sandwiched between two thin layers of a flat laminate. The core may be foam or a honeycomb shaped material. Common honeycomb materials are aluminum foil, and a paper-like organic material called Nomex®. Sandwiched panels are easy to recognized because of the core. Flight control panels and various other panels are common applications for the sandwiched panel. Nose radomes have also been made using core material. (Photos 13 -16)

(c) FILAMENT WOUND LAMINATE. Cylindrical, round or shell shaped parts are made by winding resin-wet fiber from a roving of fiber over a mandrel to get the desired shape. Each pass is called a layer. The process has the flexibility to tightly wind the fibers in various patterns. Different winding patterns have different strengths. The more tightly wound, the greater the strength the part will have. Storage tanks, tubes, gas cylinders (liquid oxygen bottles, LOX), rocket motors and nose radomes are filament wound. Filament wound parts are easy to recognize because of the winding pattern (Photo 17).

(d) HYBRID LAMINATES. It was most common to build aircraft components from unidirectional tape with a surface layer of woven fabric. Advanced materials and manufacturing techniques now include hybrid composite systems (stacking with varying types of material) with complex shapes. The design may include a metal-coated fiber, the resin may contain metal particulate or a metal mesh layer may be incorporated between the layers to protect against lightening strikes. New aircraft and redesigns for existing aircraft are being manufactured using advanced applications. Except to see more composites at the mishap site because of this (Photo 18).

(5) FIBER - RESIN DETAILS. The strength of the composite system is in the fiber direction. The amount depends on the number of very small diameter size fibers (micron range) within the tape. Prepreg material contains thousands of long continuous length fibers. Laminate thick-ness can vary. The number of prepreg layers can range from less than 10 to more than 50. A quarter inch thick, four-inch square composite made from a four-inch tape prepreg 1 could have over 4 million fibers. Prepreg tapes are manufactured with a very specific amount of fiber to resin weight. The system will contain more fiber weight than resin weight. A typical weight ratio is 65% fiber to 35% resin. For example, the F-16C/D contains approximately 200lbs of composite. If the composites were made from **just** prepreg tape, 130lb of the composite would be fiber weight.

b. MISHAP DAMAGED COMPOSITES. An undamaged composite looks and behaves like a homogenous solid. It is almost impossible to determine if the material is a composite under the coatings unless the design includes a textured surface layer like a woven fabric. When the composite is damaged it becomes obvious it is a "SYSTEM"[14] of materials. When damaged, the materials within the system begin to separate.

(1) DESCRIPTION OF MISHAP PIECES. Paragraph 3.7a gave general information for the types of material in a composite system and the various finished forms a part may have. This will help with the identification of the undamaged pieces. However, information is needed to determine what damaged debris looks like. Damaged debris is categorized in the following way (largest to smallest in size):

(a) FRAGMENTS. Whole laminate pieces, bulk composite debris is termed fragments. Impact fragments can be found within the emergency response cordon, in the impact crater or in the debris field some distance from the crater. Because of their weight, fragments will not travel far from their initial contact with the ground. (PHOTO 19,20)

(b) STRIPS. Single laminate layers are called strips. Damage can cause the layers to separate. Strips produced from physical damage will have resin attached to the fibers except at the fractured ends and will be found close to the originating composite part. If a separation was caused by fire damage very little resin or char material may be holding the fibers together. Fire generated strips will be found both within and right outside the combustion zone. (PHOTO 21)

(c) FIBER BUNDLES. Bundles are broken fiber/matrix pieces created only by physical damage. When the composite breaks the fiber and matrix cracks creating broken fiber/matrix sections. It could crack within a layer or between layers. The fibers are hold together by the matrix creating a bundle of fibers. Fiber bundles are found on and near the fracture surfaces (on the debris surface and within the laminate layers). If the fracture damage was severe bundles will be dispersed all around the immediate area. (PHOTO 22, 23)

(d) CLUSTER. A cluster contains hundreds or thousands of long continuous length fibers generated from a fire exposed unidirectional tape or filament wound layer. Clusters differ from the strip by the amount of time spent in the fire. Cluster will have very little resin or resin char holding the fibers together. The fibers will be free to move. Carbon fiber clusters are dark wooly looking resembling a clump of hair. If produced cluster can be found dispersed around the site and outside of the combustion zone or attached to strips. Clusters will not remain airborne. (PHOTO 24)

(e) DUST. Damage creates composite dust. The dust is shattered or crushed resin and fiber fragments. Fire damage creates resin char, degraded fiber dust and fuel soot. Microscopic dimensions will vary. Resin char and soot particles will be spherical in size. The dust generated from crushed resin or fiber and burnt fibers will have irregular shapes. The more severe the damage the greater the dust generation will be. Dust will be found on and near the damaged surfaces. (Photo 22)

(f) SINGLE FIBER. Single fibers are fibers that are small enough to become airborne. Depending on the size, airborne fibers may not be visible. Physical damage causes fiber sections to pull out of the matrix. Single fibers produced from physical damage are not a source of free-floating fibers at a mishap site. A carbon fiber unidirectional tape laminate when engulfed in a JP8 fire is the major source for free-floating fibers that can linger right at the burnt debris for a period of time. (PHOTO 25)

(2) PHYSICAL DAMAGE. Composites are brittle or tough and do not bend like metal when stressed. At failure the system will develop matrix and fiber fracture lines. How and where a composite material will fracture depends on the direction of the load, fiber orientation in each layer, and the type of material within the system. Damage can occur either primarily within the matrix or can affect both the fiber and matrix. Aircraft mishaps will affect both. The severity of the damage (the amount and length of fracture or crack lines) will

[14] Composites are a "system" of two or more *unlike* materials, paragraph 3.7a

determine what type of debris and how much is generated. Severe impact damage crushes and shatters the material into pieces of varying sizes.

(a) SOLID LAMINATE. When damaged the matrix forms crack lines between the layers and between the fibers within a layer (PHOTO 26). A severe matrix fracture between layers will cause a complete separation of layers known as delamination. Delamination exposes individual layers within the laminate stack. Identification of the composite system can be attempted because the type of prepreg tape, fiber direction and core material is exposed. Under severe load the fiber bends, kinks, buckles, or begins to shear apart causing the fiber to finally crack. Fracture lines can advance through layers breaking fibers into shorter sections creating fiber bundles (Photo 27,28). Most of the synthetic fibers will shear, buckle or bend creating irregular fiber fracture surfaces at the break. The original fiber diameter will be retained (PHOTO 29,30). Kevlar® is one fiber that responds differently. A fracture produces a surface layer of fibrils instead of cracking. The parent fiber divides into smaller size fibers called fibrils. The original diameter of the parent fiber has been changed by the creation of fibrils and the fibrils have smaller size diameters than the original parent fiber diameter (PHOTO 31).

(b) SANDWICHED LAMINATE. In addition to the damage described for the solid laminate, a sandwiched panel can develop separations between the surface layers and the core. The core can be crushed and torn. (PHOTO 32)

(c) FILAMENT WOUND LAMINATE. Matrix and fiber cracking occurs as explained for the solid laminate. Layers separate creating fiber/matrix strips. The winding pattern unravels revealing each individual winding layer. (PHOTO 33)

(d) DEBRIS TYPES. Using the terms described in paragraph 3.7.b.1, the type of physically damaged debris that can be produced are fragments, strips, and dust. The dust includes fiber bundles, minute amount of single fibers, resin and fiber particulate. The particulate does not linger in the air (excluding detached Kevlar® fibrils). Fibers are exposed on the surfaces and at the ends of the broken pieces. Small fiber bundles and dust will be laying on the surfaces of the damaged pieces and in the immediate area. There may not be any surface indications that reveal internal damage. Material failure due to excessive load doesn't shatter the material that is common for impact damage.

(e) FIBER PATTERN EFFECTS. The finished form of the material affects the way the composite releases broken and separated debris. Fibers are held tightly together in a fabric or filament wound part. The fabric weave and complex winding patterns inhibit movement of the fracture surfaces and fiber layers. In comparison to the unidirectional tape layer, less fraying and fiber separation is observed and the weave sustains for the most part.

(f) HEALTH CONCERNS. Generally, released particulate concentrations remain close to their point of origin. In the case of localized damage, the particulate concentration will be right at the fracture surface. Extensive damage will produce particulate that will be dispersed in close vicinity of the shattered piece. Wind and site conditions will influence the dispersion while handling the broken pieces. The exposure concerns are: sensitization response from dermal contact with the dust, puncture wounds from fiber bundles, eye and throat irritation from internal and surface particulate.

(3) FIRE DAMAGE

(a) EFFECTS OF HEAT AND FIRE. There are physical and chemical changes that occur to the materials within the composite system. Fuel fires such as JP8 fires create extremely high temperatures that can exceed 2000°F. As the heat penetrates the layers the coatings are burned off and the resin layers are thermally and oxidatively attacked. Heat causes the macromolecules to break apart into smaller and smaller size molecules creating char material and volatiles (an analogy would be the refining of crude oil to obtain lighter grades of fuel oil). When volatile concentration reach combustion levels flaming combustion occurs.

When the resin no longer seals and supports the fiber, the composite layers become unattached. Without the solid matrix air can move between the fibers, within and between the layers. A fiber layer without resin is very light and the thermal column within the flame can release surface layers outside of the burn area. Fibers decompose or melt. Fibers that melt are Spectra® and glass. Kevlar® and carbon fiber is oxidatively attacked and decomposes. Boron fiber surface oxidizes causing a change in color.

A heat source is needed to ignite a composite. Ignition temperature depends on the resin type and will vary. When the composite does ignite some resin systems become a source of fuel and add heat to the JP8 flame. Some resins give off more dense black smoke than others but liquid fuels like JP8 will be the major contributor to smoke density in a composite fire. Char formation will also depend on the resin type.

Most epoxy formulations will start to burn around 440-500°F. As the JP8 flame temperature penetrates the composite, the epoxy decomposes in a matter of seconds. If the composite laminate is not very thin, epoxy will begin to smolder after the flame ceases at a much lower temperature than the flame temperature. The smoldering is described as a slow, flameless form of combustion emitting toxic compounds. It is difficult to detect epoxy smoldering because little or no visible smoke is produced (smoke is being produced, it is just not detectable in the visible range). Smoldering epoxy is not sensitive to wind and does not spread to areas that didn't previously experience an increase in temperature. Smoldering composites are dangerous because the condition can go undetected and can easily transition to flaming combustion.

Carbon fiber combustion starts to occur when most or all resin has burned off and the external heat is around 1000°F (fiber type dependent). This is the stage when carbon fiber oxidizes and decomposes. Adequate airflow is needed to supply sufficient oxygen to self-sustain. A red glow is visible at higher temperatures (~1400°F). Smoldering epoxy doesn't generate enough heat to cause carbon fiber combustion.

(b) COMBUSTION PRODUCTS. The final combustion products for all organic material are carbon, carbon dioxide (CO_2) and water. Complete combustion is never reached. Carbon monoxide (CO) and many other products of incomplete combustion will be produced. See Table XX for a list of possibilities.

1 JP-8 FUEL. JP-8 fuel consists of aliphatic and aromatic hydrocarbons (see Table D-1) with small amounts of proprietary additives. The plume at an aircraft mishap is a dense black sooty smoke, majority of it coming from the burning of JP-8. The smoke contribution from the composite materials is minimal in comparison to the quantity of fuel burning. Soot is carbon particles and products of incomplete combustion. The soot has a very small particle size, therefore will rise in the thermal column, become diluted and disperse downwind.

2 MISCELLANEOUS AIRCRAFT MATERIALS. In addition to carbon and hydrogen resins, adhesives, plastics, core material and coatings contain other chemical elements. Elements like oxygen, nitrogen, chlorine, bromine, fluorine, and metal oxides. These elements contribute to the increase in the amount or number of toxic gases and irritants generated (Table D-5). Toxic products released from the combustion of coatings and the composite are carried with the JP-8 smoke.

3 FIBERS. Melting glass fibers can fuse, which destroys the fiber shape. If melting glass is released during a flaming combustion stage, glass beads will form and do not remain airborne.

Burning Kevlar® fiber decomposes releasing toxic combustion products similar to burning resin, plastic or wool. When the ignition source is removed Kevlar® tape and fabrics are not expected to continue to burn. Kevlar® pulp in core material may smolder.

Carbon fiber is ~ 92-98% carbon, the remaining is nitrogen and trace processing contaminates. Burning carbon fiber releases nitrogen. Oxidation erodes the fiber causing a change in the original diameter and length of the fiber. Smaller size fibers can become airborne and remain airborne during a flaming combustion condition (PHOTO 34,35). Unidirectional carbon fiber tape engulfed in the flame for a period of time forms clusters, decomposed carbon fibers, and fiber ash. Clusters form first, then the decomposing fiber and finally the ash forms. Fiber clusters are lightweight but will not remain suspended in air. If created, clusters will be found all around the site. Clusters do not cause puncture wounds. The matrix is needed to support the fiber to provide the stiffness necessary to cause a puncture. Small size fibers will travel with the plume but starts to settle out while the plume continues downwind. Due to surface winds, plumes are almost always tilted. Higher wind velocities increase the plumes angle of tilt that will result in a limited plume rise and the potential for an increased ground level concentration. Single carbon fibers are hard to see floating in the air. They may linger around the burnt debris after the fire is out but will settle out. Re-suspension potential is greatest right after the initial deposit (24-48 hours). With weathering the fibers become incorporated in the environment (into the soil) and the chance of re-suspension drops quickly. Dry areas with little vegetation will increase the potential of re-suspension.

(c) RADAR ABSORBING MATERIAL (RAM) AND CONVENTIONAL COATINGS. Due to the lack of burn data for specific RAM coatings, combustion products are not assessed as greater health hazard than those of the existing composite materials or conventional coatings. Conventional coatings for corrosion and electrostatic discharge concerns are based on organic polymers with the addition of metallic compounds. The RAM sold is also polymeric based (resins), with the addition of metallic compounds. Polymeric coatings will burn as described for the resin releasing similar combustion products. Depending on the type of RAM additive, the burn characteristics of RAM coatings may differ from those of conventional coatings. The mishap concern for coatings are the same as those of the resin, such as emission of toxic combustion products into the plume any unexpected burn conditions caused by the addition of additives.

(d) FIBER PATTERN EFFECTS. The fiber form of the composite layer influences the release of fire-damaged particulate in the same way it influences a release for physically damaged composites (3.7.b.2.e). Patterns in the filament wound part and the cross weave of the woven fabric holds fibers in place not allowing for the free movement of the individual fibers. The inability of the fibers to move freely decreases the amount of particulate released during flaming combustion. Unidirectional tape does allow for an easier release and contributes to most of the carbon fiber particulate release during a fire and when handling fire damaged carbon fiber debris.

(4) FIRE SCENARIOS.

(a) FIREBALL. Upon impact fuel and vapor is suddenly dispersed over a large area of the site. A mist of fuel vapor ignites; creating the fireball that very rapidly follows the spread of fuel. Extent of composite damage caused by fireballs varies depending on where the debris lands after impact. The fireballs path may miss the pieces completely, cause slight surface-scorch or entirely engulfed the debris. Even though fireballs can create very, very hot flame temperatures (2400°F) extent of fire damage depends on the time within the fireballs path. (PHOTO 36,37)

(b) POOL FIRE. Pool fire is the scenario that can create the greatest amount of fire damage. Quantities of fuel have collected in a relatively small area creating a pool. The flaming combustion stage of a pool fire can be much longer than for a fireball (the fuel is not used up as rapidly as within a fireball scenario). More time spent at high temperatures allows the flame and heat to penetrate many more composite layers causing more damage and also produces the conditions for a smoldering combustion stage. (PHOTO 38)

(c) LOW TEMPERATURE HEATING OVER TIME. The ignition source may determine whether a composite material burns in the smoldering or flaming mode. A slow but low temperature heating, such as a heated wire may lead to smoldering combustion. A restricted air supply, as in a closed compartment will promote smoldering combustion that may go undetected for a long time. A transition to flaming combustion after smoldering for a long time can produce a very rapid growing fire due to the preheating of the fuels, and the accumulation of combustible gases during the smoldering phase.

(d) IN-FLIGHT FIRES. The generation of smoke and toxic gases provides the first evidence that a fire is developing. The distinct odor produced by burning composites is noticeable right away. While the smoke immediately impairs visibility, the rapid generation of acutely toxic compounds presents an even greater danger. The confined space of aircraft cockpits increase toxicity because limited ventilation contributes to the increase of toxic gas concentrations. If a rapid generation of toxic gases in confined spaces ignites, a very rapid destructive fire can result.

(5) HEALTH

(a) SMOKE PLUME. Smoke contains airborne solid and liquid particulates, and gases which can be toxic if concentrations are high enough. Foremost among the hazards are impaired vision from eye irritation, narcosis from inhalation of asphyxiants and irritation of the upper/or lower respiratory tracts. The emergency phase of the mishap is concerned with the most dangerous or lethal hazards of the smoke, which are the asphyxiants and irritants. Carbon monoxide and hydrogen cyanide are the primary toxic or lethal gases in smoke. The predominant irritants are the acid gases (hydrochloric acid, hydrogen bromide, and hydrogen fluoride HCl, HBr, HF), nitrogen oxide compounds, and organic irritants like acrolein, formaldehyde, and isocyantes. When a material burns carbon monoxide, carbon dioxide and water is formed along with products of incomplete combustion. The chemical composition of the material is used to predict possible incomplete combustion products. If the material contains nitrogen, hydrogen cyanide (HCN) and nitrogen dioxide are likely to be generated. Nylon, polyurethane is two resins containing nitrogen. Halogenated or flame retardant materials produce the acid gases (HCl, HBr, HF). Aerospace resins and adhesives are likely to contain halogenated compounds. If oxygen is part of the chemical composition of the material, acrolein and formaldehyde may form. Polyesters, acrylics, epoxies and phenolic resins contain oxygen. Isocyantes form from burning polyurethane resins but the major fuel at an aircraft mishap is JP8. JP8 will be the major contributor of toxic gases in the smoke plume during a flaming composition state, see Table D-56

(b) SMOLDERING. A smoldering condition for any material produces harmful smoke. Carbon monoxide and dioxide is formed along with products of incomplete combustion. Many of the products produced are different from a flaming combustion state because of the lower temperature at which smoldering occurs. Harmful effects occur if concentrations are high enough. Compared with flaming combustion, smoldering is a slow process. Harmful concentrations can occur if smoldering were allowed to continue in a work environment, especially in an enclosed space or environment.

(c) AIRBORNE CARBON FIBER. A significant fiber release during a flaming combustion state will not occur for a fire-damaged-only composite or for a composite made entirely from a fabric or by filament winding. The potential of a significant fiber release during a flaming combustion state comes from a composite that was made with many layers of carbon fiber unidirectional tape that experience both physical then fire damage.

(d) HANDLING. Fire damaged composites are very fragile, more fragile than just physically damaged composites. Decomposed fibers will continue to break down when handling producing particulate. Handling burnt (decomposed) carbon fiber may produce particulate from the inhalable (nuisance) to the respirable size.

(e) STORAGE. Burnt composite may continue to off-gas for a period of time. Off-gas is a slow release of volatiles at ambient temperatures. Due to buildup of concentrations in a storage container, ventilation may be necessary when the storage container is initially opened.

(6) SAFETY.

(a) SMOKE. The formation of acidic gases from resin and plastic materials can create an acidic smoke plume. Entering a plume may cause skin burns from acidic gas penetration through the zipper or seam of the firefighter suit.

(b) SMOLDERING. Smoldering composites are difficult to extinguish with water. If the material is not entirely cooled to ambient temperature deep-seated smoldering may continue to exist. A smoldering state can easily transition to a flaming combustion condition. If smoldering goes undetected in the work environment an unexpected fire can occur.

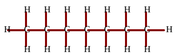
(c) CONFINED SPACE. Specific outdoor conditions may present a “confined-space” scenario at a mishap site. These conditions include thick vegetation, foliage cover, deep impact crater, pool fire as well as lack of rain and wind. Confined space increase the likelihood of hazard exposures.

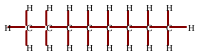
(7) MISHAP SITE MATERIAL COMPATIBILITY. A mishap may contaminate the debris with aircraft fluids, melting metals, battery acid or hydrazine. The compatibility of composite material with other materials at the site is found below.

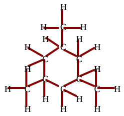
QUICK REFERENCE TABLES. A number of tables have been provided to assist with the reading.

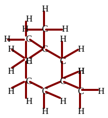
TABLE	TITLE	NUMBER OF TABLE PAGES
Table D-1	**JP8 Constituents**	**1**
Table D-2	**Mishap Composite Material Compatibility**	**1**
Table D-3	**Mishap-Composite Identification Information**	**1**
Table D-4	**Fire Damage Evidence**	**1**
Table D-5	**Combustion Products**	**1**

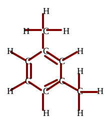
Table D-1. JP8 Constituents

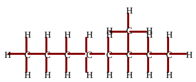
n-heptane 

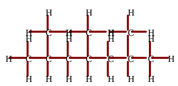
n-octane 

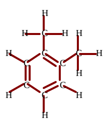


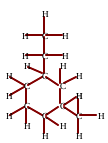


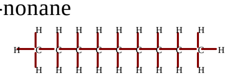
m-xylene 

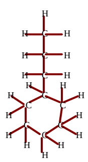
3-methyloctane 

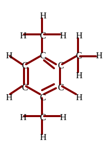
2,4,6-trimethylheptane 

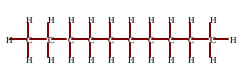
o-xylene 

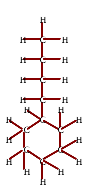
cis-1-ethyl-3-methylcyclohexane 

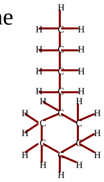
n-nonane 

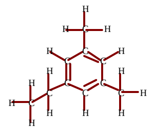
n-propylcyclohexane 

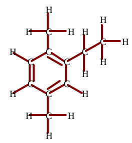
1,2,4-trimethylbenzene 

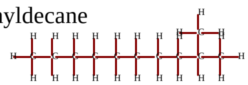
n-decane 

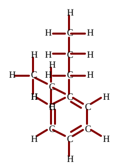
n-butylcyclohexane 

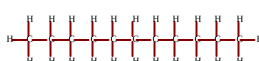
n-butylcyclohexane 

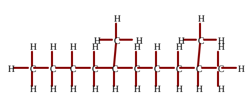
1,3-dimethyl-5-ethylbenzene 

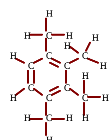
1,4-dimethyl-2-ethylbenzene 

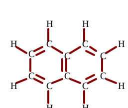
2-methyldecane 

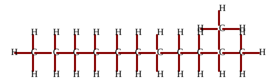
1-ethylpropylbenzene 

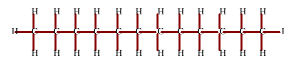
n-undecane 

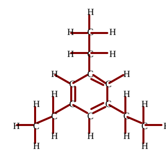
2,6-dimethyldecane 

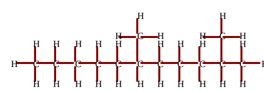
1,2,3,4-tetramethylbenzene 

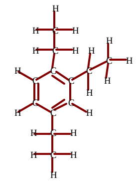
naphthalene 

2-methylundecane 

n-dodecane 

1,3,5-triethylbenzene 

2,6-dimethylundecane 

1,2,4-triethylbenzene 

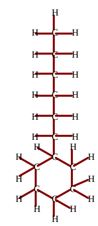
n-hexylcyclohexane 

Table D-2. Mishap-Composite Material Compatibility

	Reactivity: The ability of the material to release energy in combination with other material.						
	Carbon	**Glass**	**Boron**	**Kevlar**	**Epoxide**	**PEEK**	**BMI**
Molten Al, Ti	NR	NR	R	NR	NR	NR	NR
Hydrazine	Individual components listed are NR. Interaction with paper-like honeycomb core material, foam and severely shattered composite debris may be reactive.						
A/C Fuels	NR	NR	NR	NR	NR	NR	NR
Hydraulic Fluid	NR	NR	NR	NR	NR	NR	NR
Hypergolic Mixtures	A hypergolic mixture may be reactive depending on the type of mixture. Mixtures containing hydrazine are highly suspect.						
Liquid Oxygen	Interaction with the matrix, Kevlar® fiber or the organic core material may be reactive. Epoxy becomes shock sensitive in combination with LOX.						
Battery Acid	NR	NR	NR	NR	NR	NR	NR
BBP and NBC Decon Soln.	NR	NR	NR	NR	NR	NR	NR
	NR = NON-REACTIVE						

	Materials Resistance to Chemical Degradation Exposure time dependent							
	Carbon	**Glass** E	S	**Boron**	**Kevlar**	**Epoxide**	**PEEK**	**BMI**
Strong Acid	R	SA	R	A	A	SA (sulfuric acid)	SA	A
Weak Acid	R	SA	R	R	R	SA (acetic acid)	R	R
Strong Alkalis	R	SA	SA	R	A	R	SA	A
Weak Alkali	R	R	R	R	R	R	R	R
AFFF	It becomes corrosive when diluted with water. Use corrosive property to make a judgment.							
Hydraulic fluids	R	R	R	R	A	R	SA	R
Organic Solvents	A (halogenated)	R	R	R	R	R	R	R
BBE and NBC "decon" solution	R	R	R	R	R	-	R	R
	The "decon" solution is a diluted bleach solution. Bleach is an oxidizer. Strong oxidizers affect epoxy.							
Hydrazine	-	A	A	-	-	-	-	A
	A = ATTACK		**SA = SLIGHT ATTACK**			**R= RESISTANT TO ATTACK**		

Table D-3. Mishap-Composite Identification Information

Fiber	Color undamaged	Color fire - damaged	Original Diameter size (µm)	Thermal Damage	Application
Carbon	black odorless	black	5-10	Oxidation: varies with fiber type 660 -1000°F Melting point 6600°F	Primary and secondary structures
Glass (E and S)	white or transparent	char color on surface	4-13	Melting point 1550°F for E glass and 1778°F for S Glass noncombustible	Radome, sacrificial surface layer and corrosion protection layer between carbon and metal, Secondary structures.
Kevlar®	yellow	brown	12	Decomposes 930 °F. Total ash occurs at 1292°F	Areas where impact is a concern.
Boron	black	black	100 and 140 (tungsten boride core 7.5)	Melting point boron 4172°F tungsten boride 5252°F ignites 1112°F with a brilliant green flame oxidizes above 930°	Anywhere high strength and stiffness is needed. Very limited application. F-15, F-14, B1 and repair patch for metallic structures (C-130, C-141).
Quartz	white to reddish	surface char	4-10	Melting point 3121°F noncombustible	Radome
Spectra®	opaque	char	4-12	Melting point 297°F ignites around 660°F	Radome

NOTE:
The composite systems color could be attributed to either the resin or fiber. A general rule of thumb follows.

Composite: Color will be from the resin if the fiber is one of the lighter colored fibers.

Fiber: A black or dark appearance is from carbon fiber unless the fiber diameter size is as large as human hair then it would be boron.

Table D-4. Fire Damage Evidence

Material (°F)	Observation
Aircraft Epoxy Paint	
400	softens
600	discolors
800-850	blisters
900-950	burns off
Zinc Chromate Primer	
900-950	burns off
800-850	blisters
700	black
600	dark brown
500	brown
540	tan
Stainless steel	
800-900	tan to light blue to bright blue to black
2700	melts
Titanium	
1100	
1300	blue, scale form
1200-1500	oxide scale
1620	gray or yellow
3100	allotropic transformation
5600	melts
	TiO_2 boils, burn
Aluminum	
1000-1200	melts
Carbon fiber	
1000 or above	individual fibers or very small fiber bundles are turning ash in color.
1400	glowing red
Boron	
?	gray
Glass	
1550	beads form
Kevlar	
800-900	brown
Epoxy	
above 500	shiny surface

Table D-5. Combustion Products

MATERIAL	PRODUCTS (in addition to C, CO, CO_2, H_20)
Fiber	
Carbon (PAN based)	nitrogen, oxides of carbon
Kevlar®	C_2H_4, CH_4, NO_x, HCN, NH_3, aldehydes, aliphatic hydrocarbons
Boron/tungsten	boron oxides
Glass	Non-flammable. Products of combustion are from the combustion of the sizing material.
SPECTRA (HD polyethylene)	Short chain aldehydes, long chain hydrocarbon, acrolein
Resin	
Epoxide - amine cured (more flammable than most thermoset resins)	CH_4, CH_2CH_2, CH_3CH_3 propane, propylene aniline dimethylaniline toluidine acrolein, phenols, amines, aldehydes, aromatic amines, hydrofluoric and fluoroboric acid,
Nylon	amines, ammonia, cyclic ketones, esters, hydrogen cyanide, benzene
Phenolics	acetone, formaldehyde, methane, phenol
Polyamide	ammonia, cyanides, NO_x
Polycarbonate	short-chain aldehydes and ketones
Polyimide	hydrogen aniline, phenol, benzene
Polypropylene	Short chain aldehydes, long chain hydrocarbon, acrolein, formaldehyde
Polystryene	benzene, styrene, toluene, acrolein
Foams	
Phenolic	See resin above
Polypropylene	See resin above
Polyvinyl chloride (Tradename: Divinycell, Legecell, Airex)	HCl, HCN, NO_x
Polystryene (Styrofoam)	ethyl benzene, aldehydes, aromatics, HFl, HBr, (depends on manufacturer)
Polyurethane foams	toluene, HCN, isocyantes, TDI
Polymethacrylimide (tradename: Rohacell)	Rohacell A: nitriles Rohacell S: nitriles, phosphoric acid, phosphorus oxides
Core	
Kevlar, fiberglass, or carbon fiber substrate coated with one of the following: Phenolic (NOMEX) polyimide epoxy	 See resin information above See resin information above See resin information above
Fuel	
JP8	sulfur oxides sulfur particulate short chain aldehydes intermediate hydrocarbons – aromatic and aliphatic polynuclear aromatic residual JP8 fuel

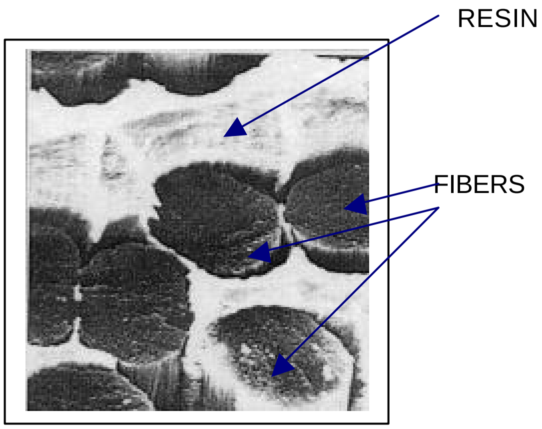


Photo 1. Microscopic view fiber/matrix

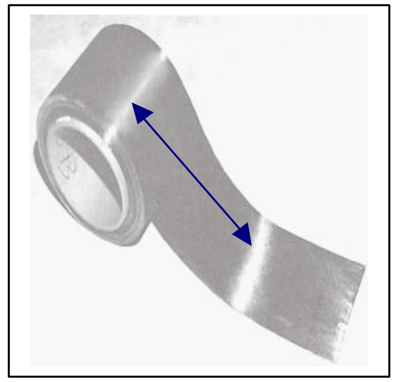


Photo 2. Unidirectional carbon fiber tape prepreg

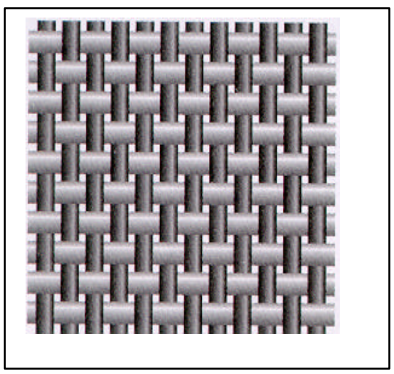


Photo 3. Plain Weave Fabric

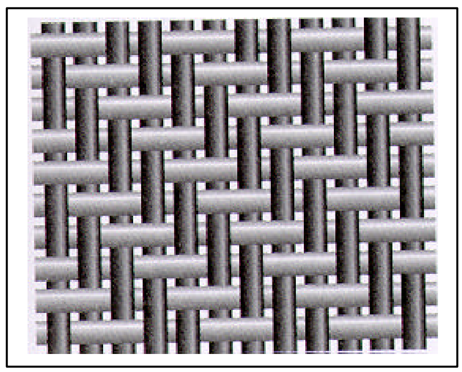


Photo 4. Twill Weave Fabric

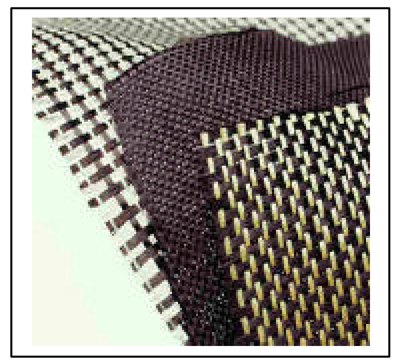
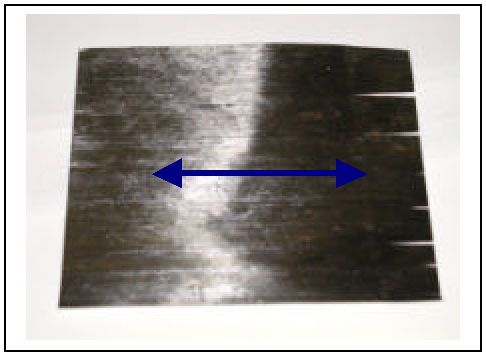


Photo 5. Assorted Fabric

Photo 6. Carbon Fiber Tape

Photo 7. Glass Fiber Tape

Photo 8. Roving Carbon Fiber



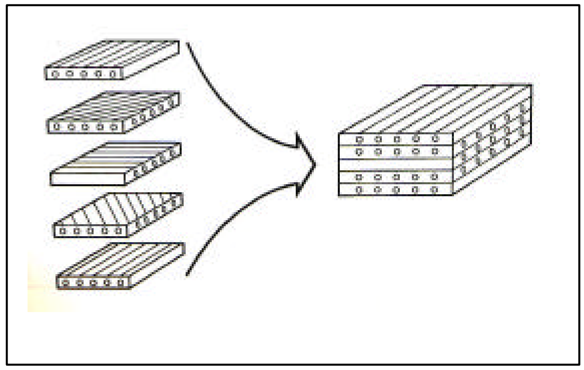
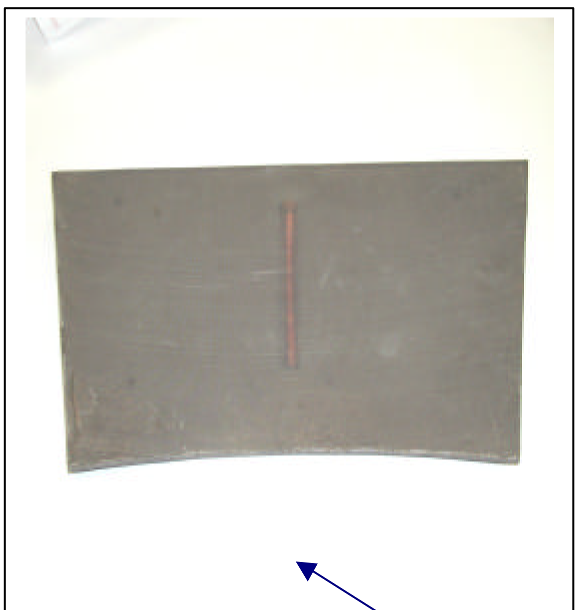
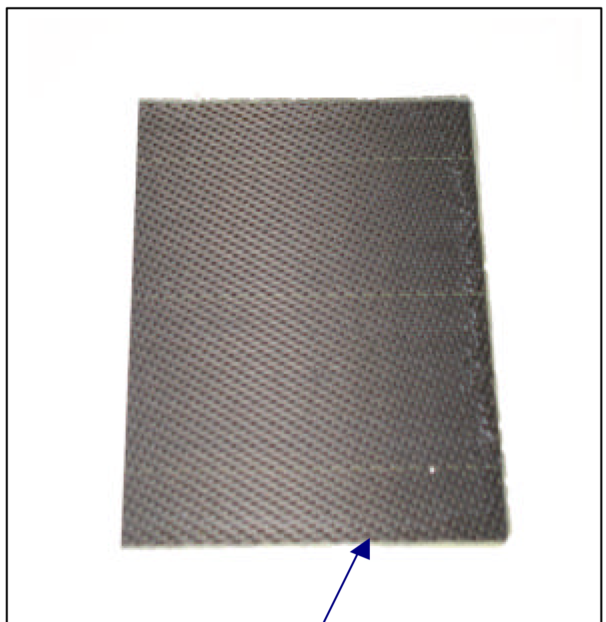


Photo 9 Photo 10

Preparing to build the part by stacking layers of unidirectional carbon fiber tape.





Photos 11 and 12. Top view -solid laminates. Photo 9, slightly curved assess panel. Photo 10, flat laminate with a fabric surface layer.

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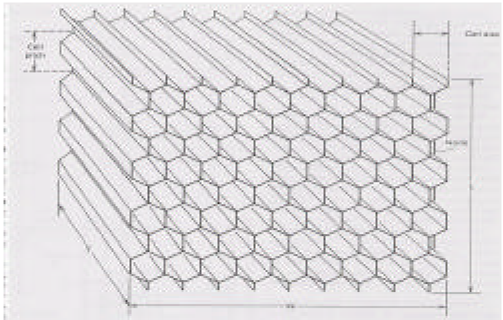
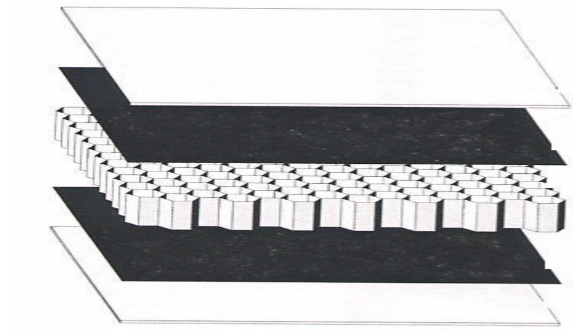
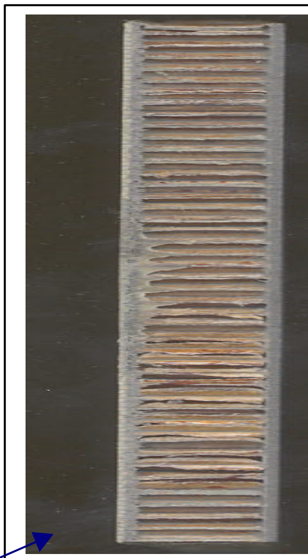




Photos 13 and 14. Honeycomb Core and Sandwich Laminate Layers.



Photos 15 and 16. Top and Side View of a Sandwich Laminate.

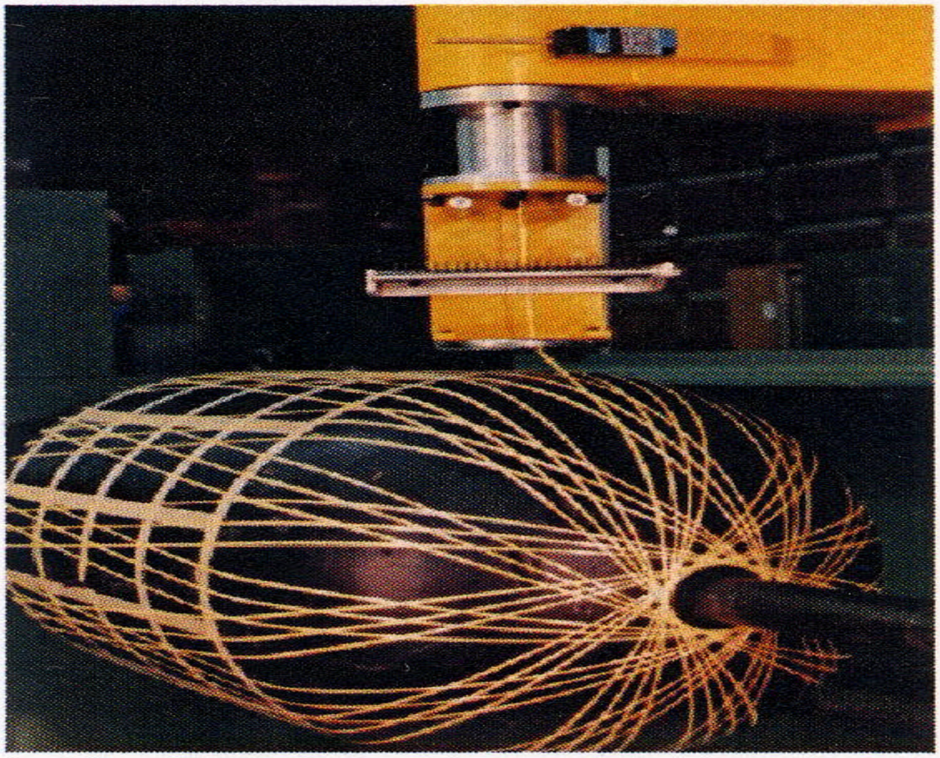


Photo 17. Filament winding process

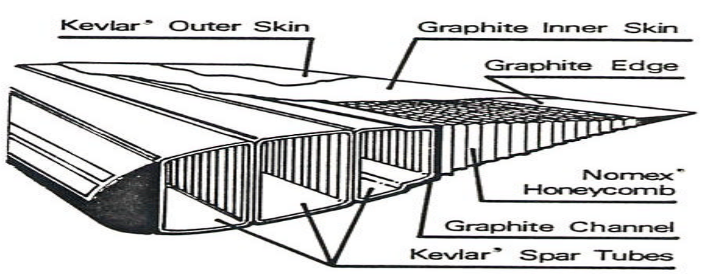


Photo 18. Hybrid aircraft composite flap

Photo 19. Fragment. Carbon Fiber Epoxy Fragment

Photo 20. Fragment. Carbon Fiber Epoxy Fragment

Photo 21. Strips- Single Layers

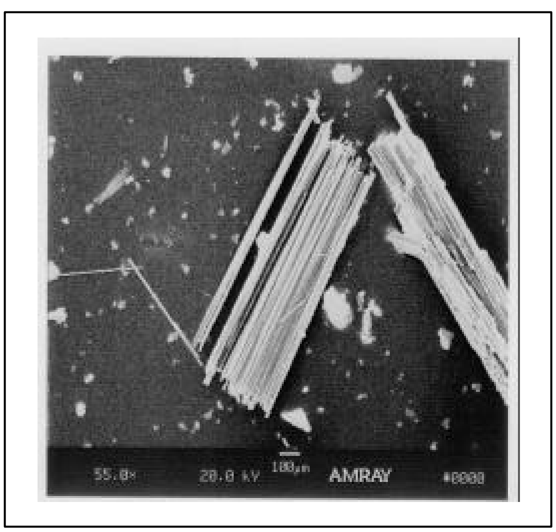


Photo 22. Microscopic view of fiber bundles, dust and single fibers

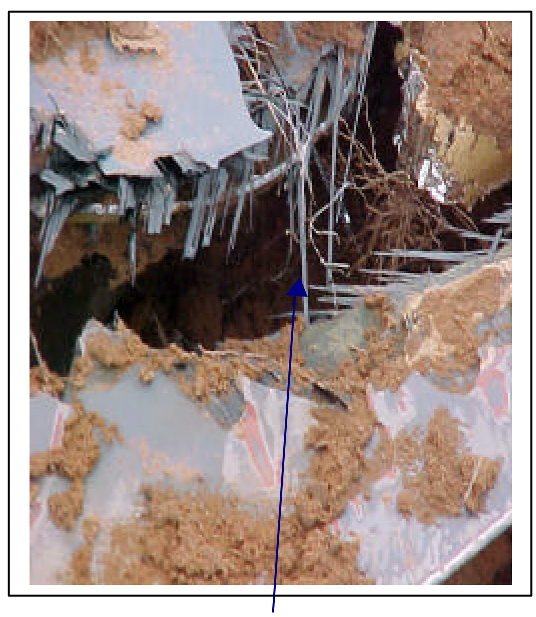


Photo 23. Large Fiber Bundles

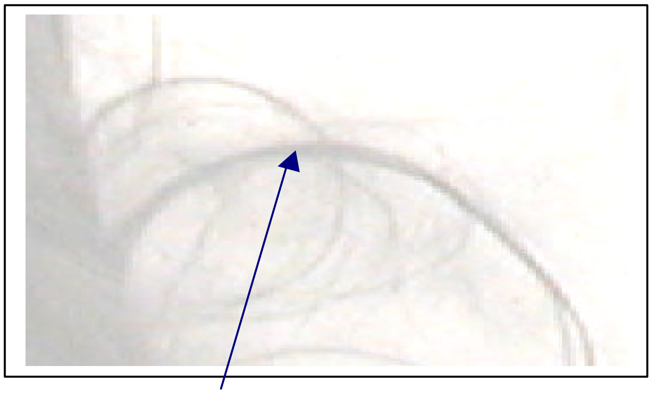


Photo 24. Carbon Fiber Clusters

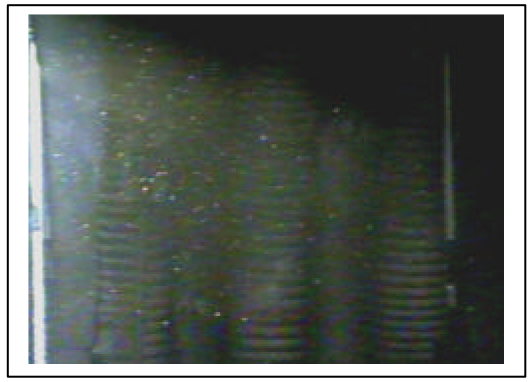


Photo 25. Airborne Fibers

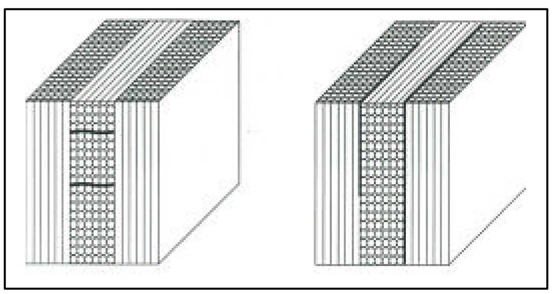


Photo 26. Cracks or Fracture Lines

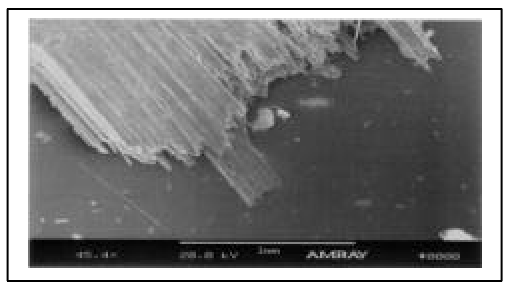


Photo 27. Microscopic view of broken fibers. Single fibers and dust is generated.

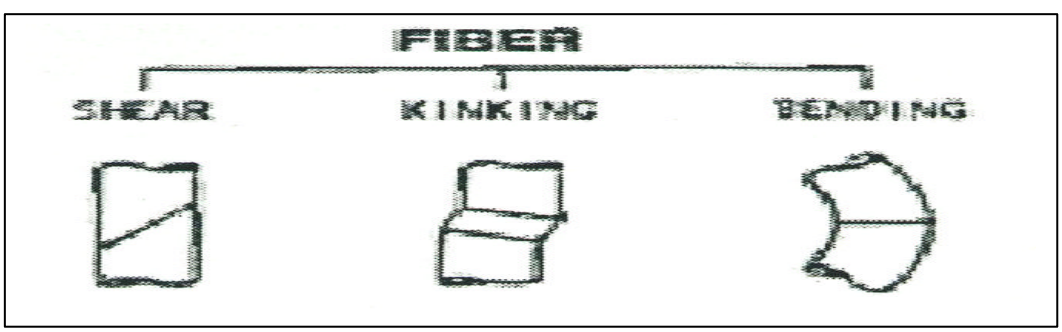


Photo 28. Fiber Stress Before It Cracks or Fractures

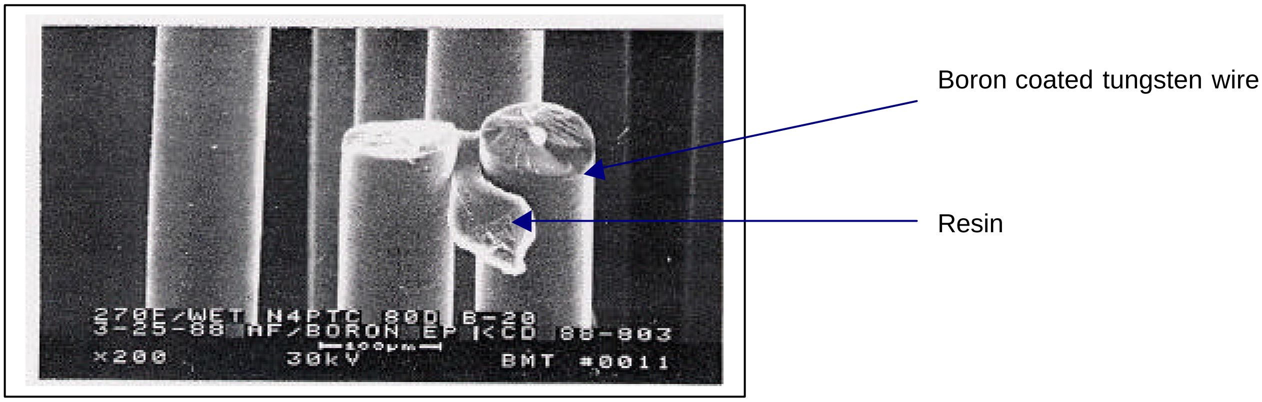


Photo 29. Microscopic view of fractured boron coated tungsten wire. A minute amount of resin is found between two fibers.

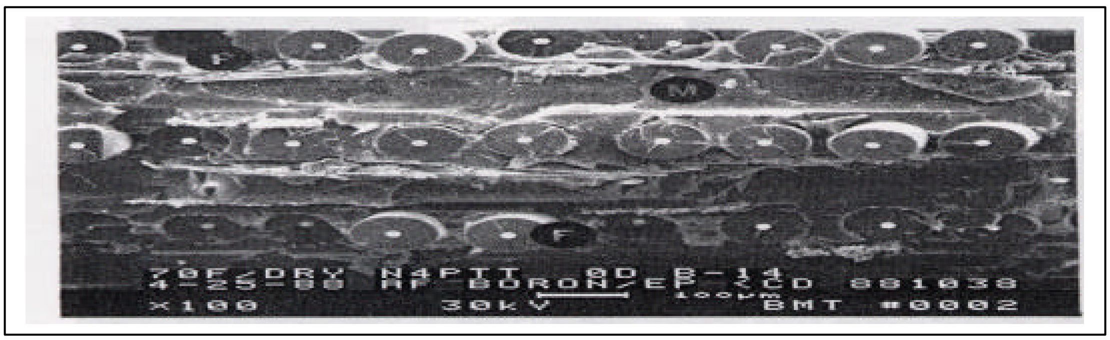


Photo 30. Side view, damaged boron fiber epoxy laminate. View shows fiber /resin cracking, delamination and fiber pull-out.

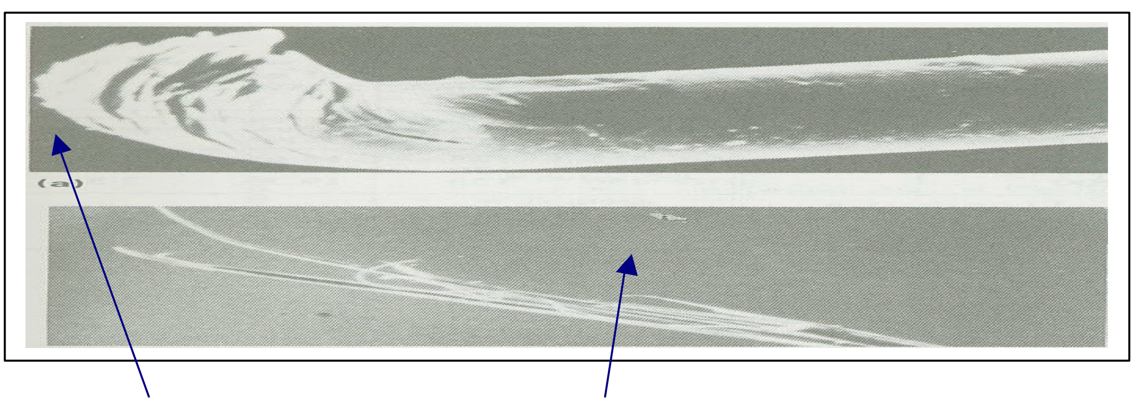


Photo 31. Top view – fibrillated Kevlar fiber end. Bottom view – severely fibrillated Kevlar fiber.

Photo 32. Repaired Sandwich Laminate. Center core removed and replaced.

Photo 33. Impact and Burnt Glass Fiber Filament Wound radome

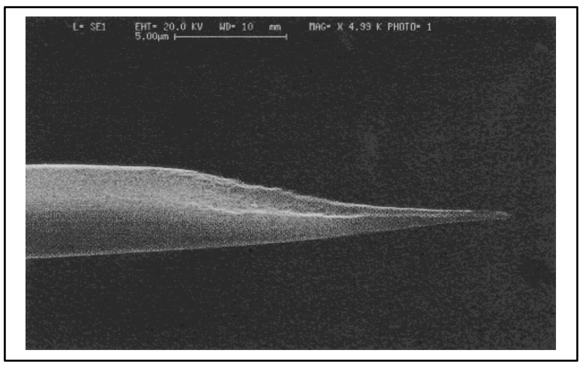


Photo 34. Burnt and Eroded Carbon Fiber

Photo 35. Burnt and Eroded Carbon Fiber

Photo 36 and 37. Fire-ball damage

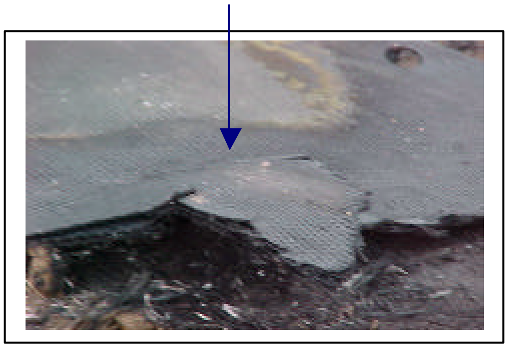


Photo 38. Pool-fire damage

APPENDIX E. DISPOSAL OF COMPOSITES.

Routine decisions made for industrial waste is not routine when determining how to dispose of mishap-composites. Characterizing mishap-composite debris for regulatory compliance requires knowledge of the materials within the system and mishap conditions. The knowledge is needed to adapt sampling plans for composite material. The knowledge is needed when reviewing regulatory lists and when interpreting analytical results. This paragraph reviews the material specific aspects for environmental concerns of mishap-composites.

a. WASTE CHARACTERIZATION. Waste characterization begins with an understanding of what the materials are within the system. A composite part is made by layering-of-material[15]. A basic system will use the same material for each layer, a polymeric resin and a synthetic fiber. A hybrid system contains different material layers. For instance, the design may incorporate a metal-coated fiber layer; a metal mesh layer or the resin may contain metal particulate. If the debris was not involved in a fire, the composite will have coatings. Waste characterization also considers what could have contaminated the composite during the mishap.

(1) Physical Damage. The chemical and physical properties of the composite used for environmental assessment has not changed when a composite fractures. The solid matrix surrounds the fiber protecting it from environmental exposure. Disposal concerns are the same as the undamaged part.

(2) Fire Damage. Chemical and physical changes do occur when a composite is thermally damaged. Fibers melt, oxidize or decompose. The resin melts, oxidizes, decomposes, volatilizes and forms a char[16] layer. Post-fire material is in a solid form. The decomposition products of the materials will vary widely and may be a potential environmental hazard if present in detectable concentrations. The decomposition products for JP8 fuel will also be present.

(3) Mishap-Site Contamination. Was the debris JP8 soaked, AFFF soaked or hydraulic fuel soaked? Is the hold-down solution environmentally friendly?

b. SAMPLING.

(1) Amount. Most of the composites in an aircraft will take the form of a solid laminate or sandwich laminate. Each form will be considerably less dense than soil or sludge of the same volume. The four-ounce soil jar used for organic sampling may not hold the minimum amount of sample required for TLCP[17] analysis.

(2) Collection and handling method**.** Zero headspace will be hard to achieve because the form may not allow for compaction within the sampling jar. Cutting composites out in the field to fit into a sampling jar will require special tools and personal protection equipment. Avoid cutting in the field if at all possible.

(3) Selection of sampling location. Because composites are made with layers sample selection could mistakenly leave out the layer that could be of concern. Composite[18] sampling should be used. However, results obtained from composite sampling of a mishap-composite is considered representative of only one specific site and sample type.

(4) To minimize worker exposure to particulate when sampling and handling burnt carbon fiber composites, glass bottle is preferred over plastic.

c. SAMPLE PREPARATION. The sample preparation step for a volatile analysis is performed with or without heat depending on the sample type. If a fire-damaged sample is going to be analyzed (and not it's leachate), handle it just like it was a soil. The carbonaceous nature of the char and soot material will require heat to desorbed combustion products.

d. ANALYSIS. To determine what constituents to test for, and what concentrations to expect a better understanding of the material in relationship to the analytical methods is needed. The three major components of the system to consider for environmental disposal are the fiber/matrix and core layer, the coatings layer and the hybrid layer. Generally speaking, an organic constituent may originate in the fiber/matrix, core or coating layer. The inorganic constituents may be found in the coatings or the hybrid layer.

(1) Results. There are several reasons why a non-detect might be expected. Reason one is the regulatory limits are too high. Reason two is the list doesn't reflect the type of material that is being testing.

(a) Regulatory limits. The regulatory limits for the F and D listed organic compounds are ppm levels. The lack of analytical sensitivity when reporting ppm levels may have eliminated trace or low-level compounds.

(b) Regulatory lists. The lists are generated for chemicals used in industrial processes. That is the raw

[15] Paragraph 3.7a, Basics of Composites

[16] Char = resin combustion products

[17] TCLP = toxicity characteristic leaching procedure

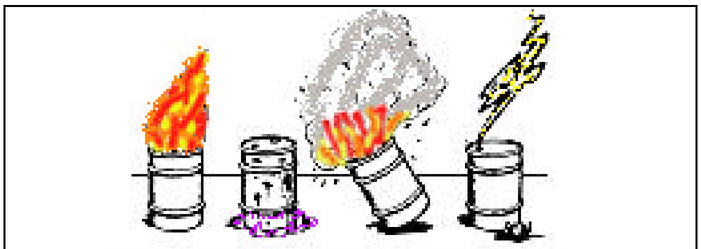
[18] Composite sampling = Sample is a nondiscrete sample composed of more than one specific sample collected at various location on site or within a bulk piece.

products used to make the composite. Once the composite material is formed to a specific shape (becomes a solid), the raw products in their original form no longer exist (or exists only in undetectable amounts). The lists may not reflect the chemistry of the solid material or it's combustion or decomposition products.

e. WASTE CATAGORIES[19]. Of the six different ways a mishap-composite could be defined as a hazardous waste, the most likely would be the "characteristic" waste or the contaminated media. Discussion for each follows.

- Listed waste (F, K, P, U)
- Mixture of solid an listed waste
- Derived from hazardous waste
- "Characteristic" waste (D)
- Contaminated debris
- Contaminated media

(1) "Characteristic" waste. Characteristics of waste that are separate from listed wastes are ignitibility, corrosivity, reactivity, and toxicity. Elimination of a characteristic is based on the chemical a physical condition of the material, the reasoning follows.



Ignitability Corrosivity Reactivity Toxicity

(a) Ignitibility. A waste is an ignitable waste if it meets any of the following.

- Liquid - Flash Point <140°F

Not applicable to mishap-composites

- Solid - Spontaneous combustion through friction.

May be applicable to mishap-composites if saturated with fuel

- Solid - Spontaneous combustion through absorption or loss of moisture.

Not applicable to mishap-composites

- Compressed gas or oxidizer defined by DOT

Not applicable to mishap-composite

(b) Corrosivity. A waste is corrosive if it meets the following conditions:

- pH ≤ 2 or ≥ 12.5

Not applicable to mishap-composites unless site contamination occurred (spilt battery acid or hazardous cargo).

Note:
Burning resins can produce an acidic plume. The resin char and fuel soot can be slightly acidic. Plume exposure or a surface layer of resin char is not expected to cause a 5-gram composite sample to have corrosive pH conditions as defined.

(c) Reactivity. A waste is reactive if it meets any of the following conditions:

- Readily undergo chemical change
- React violently or forms explosive mixture when mixed with water
- Capable of detonation or explosion when exposed to pressure and heat
- Capable of detonation or explosion at standard temperature and pressure
- Defined as a forbidden explosive or Class A or Class B explosive by DOT

Not applicable to mishap-composites.

- Toxic gas generation. Cyanide and sulfide bearing waste when exposed to mild acidic or basic conditions generates toxic gases.

- 250mg of free cyanide per kilogram of waste 500mg of free sulfide is generated per kilogram of waste

Hydrogen cyanide and sulfide are possible combustion products for various resin types. Liberation occurs at very high flame temperatures. When liberated, the compounds could condense out on nearby surfaces, react with other chemical species in the thermal column or rise with the plume. Probability of detection on a mishap-composite at the levels of concern is considered low.

(d) Toxicity. A land-disposed waste is considered toxic if it contains a toxic constituent. The constituent categories are metals, volatile and semi-volatile organics, pesticide, and herbicide.

- Metals:
  - Arsenic
  - Barium
  - Cadmium

[19] 40CFR 261

Chromium
Lead
Mercury
Selenium
Silver

Several of the metals could be present in reportable concentrations.

- Volatile Organics
  - Benzene
  - Carbon tetrachloride
  - Chlorobenzene
  - Chloroform
  - 1,2-dichloroethane
  - Hexachloroethane
  - Methyl ethyl ketone
  - Tetrachloroethylene
  - Trichlorethylene
  - Trichlorethylene
  - Vinyl chloride

An undamaged or physically damaged composite is not expected to contain any residual solvents that were introduced during the production of the raw material or in the manufacturing process of the composite part. Benzene is the most likely compound from the list to be detected in a fire-damaged sample. Benzene is an expected combustion product of the fuel and resin. The char and soot may contain traces of benzene.

- Semi-volatile organics
  - o,m,or p-Cresol(s)
  - 1,4-dichlorobenzene
  - 2,4-dinitrotoluene
  - Hexachlorobenzene
  - Hexachlorobutadiene
  - Nitrobenzene
  - Pentachlorophenol
  - Pyridine
  - 2,4,5-trichlorethylene
  - 2,4,6-trichlorethylene

Chemical knowledge of a specific resin system is needed to determine if any semi-volatiles are a possibility. If a compound is found to be part of the resin formulation it is not expected to be detected once the composite has been shaped to its final form. An undamaged or physically damaged mishap-composite is not expected to contain any detectable amounts of resin monomers. Detection is highly unlikely when using the TCLP preparation method for organic constituents in a fire or physically damaged composite.

- Pesticide and Herbicides

Not applicable to mishap-composites.

2. Contaminated Media. Contamination can be caused by many sources within the mishap environment. Blood-borne pathogen exposure will make the composite debris a medical waste. Radiation exposure will cause the debris to become a radioactive waste. Exposure to hazardous liquids will cause the composite debris to become hazardous waste. Fire suppressant soaked composites may be a disposal issue. Information must be gathered at and about the mishap needed to determine if site contamination is a potential disposal problem for the mishap-composite.

(3) Landfill. Landfills do not operate under the same permit. One permit may require the D-listed compounds and another may require the F and D-listed compounds. One may require only a TCLP sample preparation while the other may require a total preparation method.

Quick Reference Table. The following table was developed to help with the selection of analytical methods to be used when the debris needs to be characterized.

TABLE	TITLE	NUMBER OF TABLE PAGES
Table E-1	**Recommended Analysis Possible Contaminants of a Fire-Damaged Composite**	**1**

Table E-1. Recommended Analysis
Possible Contaminants of a Fire-Damaged Composite

Recommended Analysis	Sample Type	Possible Contamination Levels	Comments
TPH	Composite debris	ppb, ppm, ppt	VOA and semi-volatile molecular weight range.
PAH	Composite debris	ppb or ppt	Soxhlet extraction more efficient than sonication preparation.
Semi-volatile organics	Composite debris	ppb or ppt	Soxhelt extraction more efficient than sonication preparation.
Volatile organics	Composite debris	ppb or ppt	Headspace or heated purge is an efficient preparation method.
Metals	Composite debris	ppb, ppm	
TCLP metals	Leachate	ppm, ppt	

NOTE:
Expected contamination of a fire damaged composite: PNA, hydrocarbons, resin monomers, oxidized resin and fiber compounds, petroleum fuel, aviation gas, jet propulsion fuel, halogenated products from the fire suppressant. Recommendation doesn't consider site cross-contamination possibilities.

ppt = parts per trillion ppb = parts per billion ppm = part per million